35 reduce boiler horsepower
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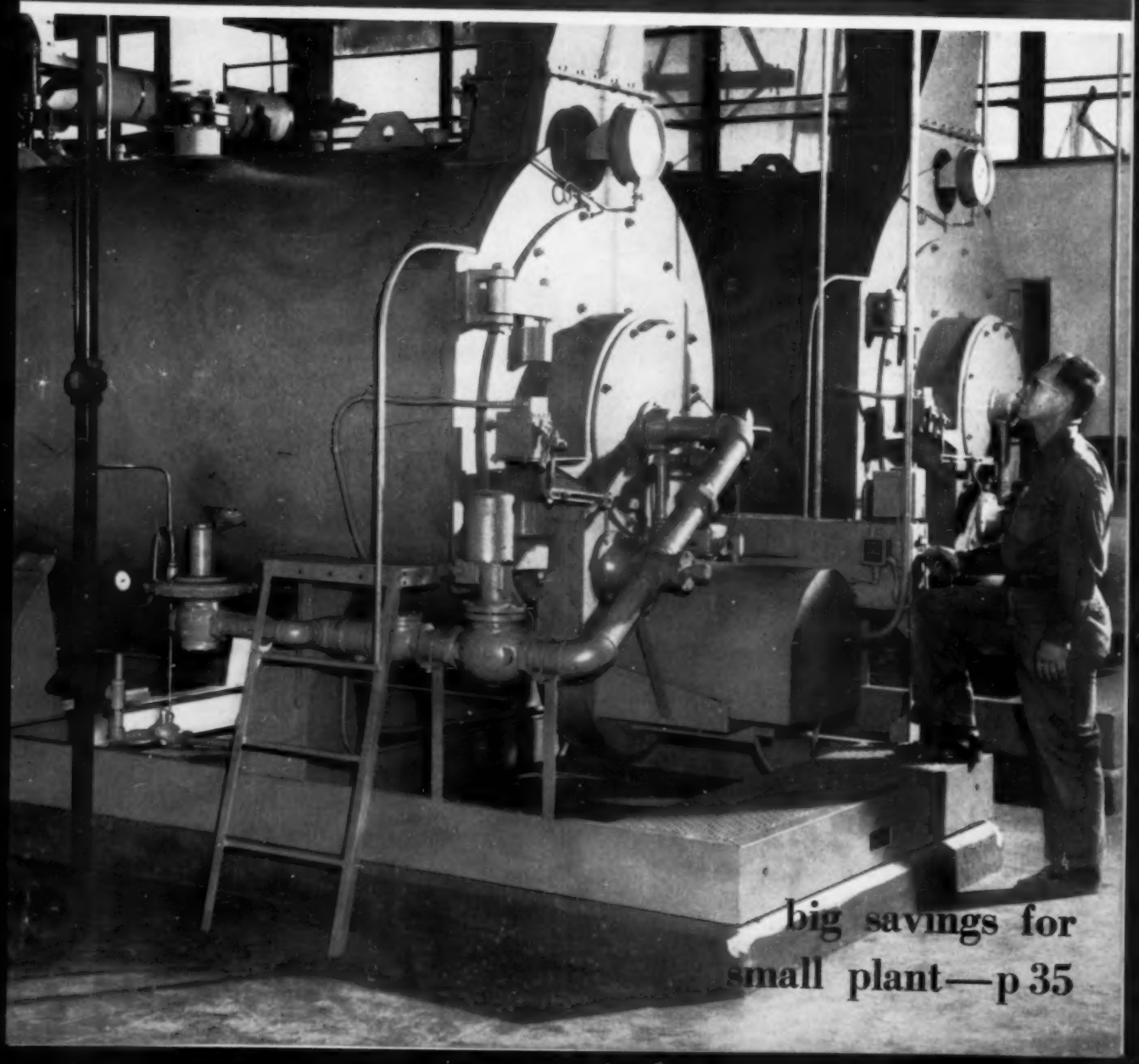
55 electrical refresher

MAY 1956

A PUTMAN PUBLICATION

Industry & Power

The magazine for men who manage power services



big savings for small plant—p 35

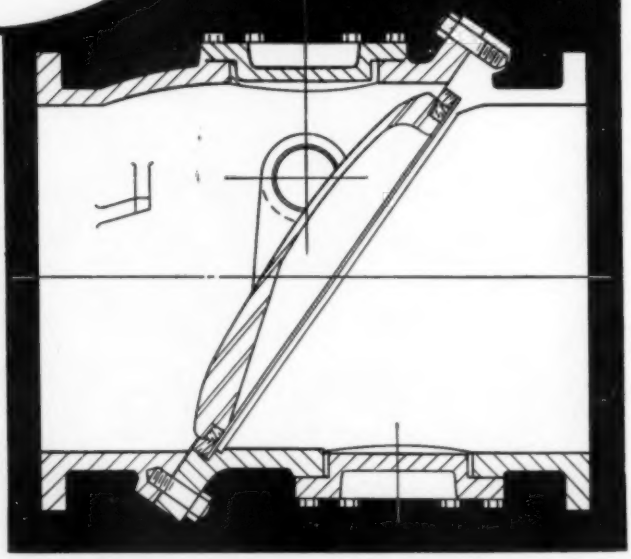
CHAPMAN TILTING DISC CHECK VALVE

the Valve with the Right Idea!

Here is a cross section of top check valve performance at lowest cost. It's the idea in back of Chapman's Tilting Disc Check Valve . . . the valve that's designed to go with the flow.

When the flow is on, specially designed "airfoil" disc balances perfectly in open position. Fluid holds it tightly against stops. There's no vibration . . . no flutter. It's quiet. And note the design. Ample room is allowed around disc to assure low flow resistance.

When the flow is reversed, disc drops surely, quietly, *tightly* on special beveled seat. There's no banging, no slamming, no scraping or wearing of disc and seat faces, no damage to piping joints or the valve itself. It's as simple as that. It's as *sound* as that. It has the right idea.



Complete information on these rugged, quiet, long life check valves is highlighted in our Catalog 30-A. Whether you want iron or steel construction . . . whether you handle fluids or gases under a wide range of pressures . . . this catalog gives you all the facts. Send for your up-to-date copy, today.

The CHAPMAN VALVE Mfg. CO.

INDIAN ORCHARD, MASS.

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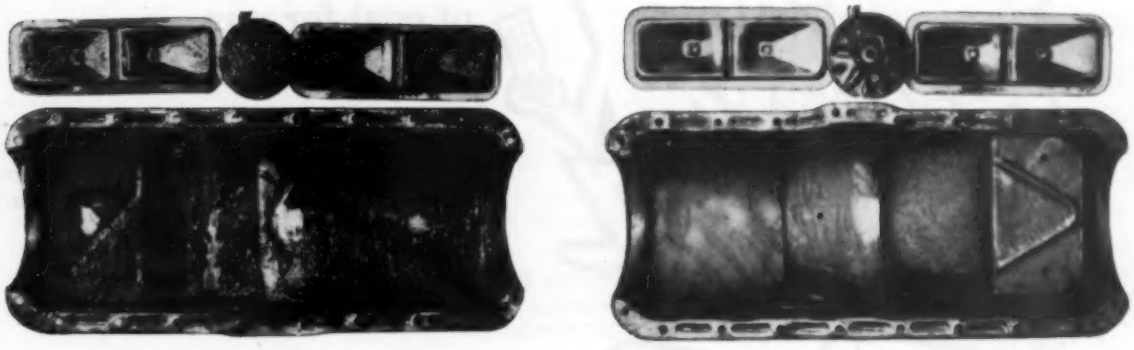
PROOF POSITIVE...

of SINCLAIR Diesel Oil Superiority!



This is actual photographic proof of the superiority of Sinclair Diesel Lubricants. On the left is a truck engine sump in which an ordinary oil was used. The clean sump on the right reflects conditions when a Sinclair Diesel Oil, SUPER TENOL, was used. This same top quality lubrication performance can be expected from all Sinclair Diesel Oils . . . *because Sinclair has the exact oil to match your engine's requirements!*

Sinclair RUBILENE® – These high viscosity index oils, refined by Sinclair's famed Phetone Process, have a long history of outstanding performance and are extensively used in stationary Diesel power plants today.

Sinclair RUBILENE HD – These high viscosity index oils contain additives which provide excellent detergent – dispersant properties, oxidation resistance, bearing corrosion prevention and anti-foam qualities. They are especially suitable for stationary Diesels as well as the higher speed Diesels used in industrial plants.

Sinclair GASCON® –These naturally detergent, straight mineral oils are recommended for slow, medium and high speed Diesels where carbon deposits, engine cleanliness and easy, low temperature starting is important.

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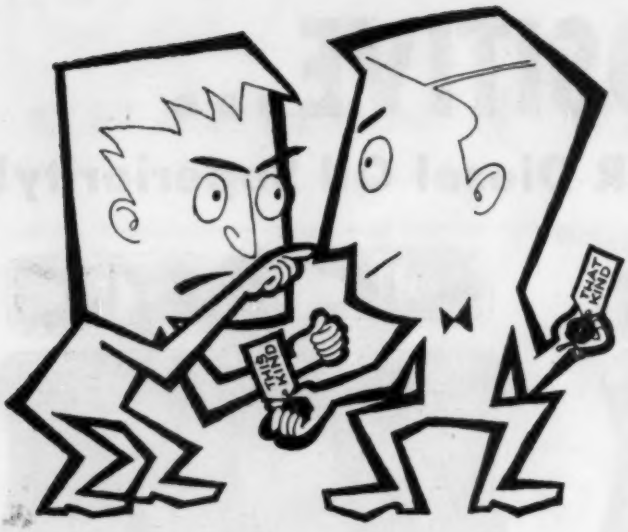
For further information about Sinclair's trouble-proof Diesel lubricants, see your Sinclair Representative, or write Sinclair Refining Company, Technical Service Division, 600 Fifth Avenue, New York 20, N. Y. *There's no obligation.*

SINCLAIR

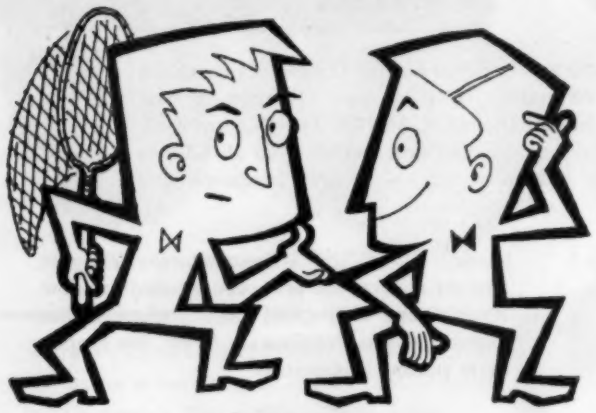
DIESEL OILS

Circle 123 on READ-N-CIRCLE card for more data



What's the big idea buying several kinds of coal for our steam plants?

It's a good idea. The kind of coal that burns most economically in the old boilers isn't efficient for the new ones.



How do you know you're right?

Look at the coal bills. We are generating more steam at a lower fuel cost. You can tell from the ashes we are getting more complete combustion, and there's less clinkering.

Where did you get this idea, anyway?

From the C & O Coal Department. They convinced us that different types of burning equipment need different types of coal. From the high quality coal produced on the C & O, we selected the quality and size of coal that works best in our particular installations.

P.S.

There's a lot more to buying coal than the cost per million BTU. Why not contact coal producers on the C & O to solve your particular fuel requirements, or write to: R. C. Riedinger, General Coal Traffic Manager, Chesapeake & Ohio Railway Co., Terminal Tower, Cleveland 1, Ohio, for the assistance of a C & O fuel service engineer.

Chesapeake and Ohio Railway

WORLD'S LARGEST CARRIER OF BITUMINOUS COAL

Circle 119 on READ-N-CIRCLE card for more data

Industry & Power

SERVING INDUSTRY'S POWER SERVICES

VOLUME 70 NO. 5 MAY 1956

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perhaps you can use a smaller boiler 35
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how Abbott slashes air conditioning upkeep 38
Planned maintenance that is keyed to a programmed punch card system is saving Abbott Laboratories 25%.

do it yourself — electronic maintenance 41
You need not pass up the benefits of modern electronic equipment because you lack specialists on your staff.

what to do about anion resin deterioration 45
Learn what factors affect anion resin life. Know the limitations and you can make a more intelligent purchase.

how they start — explosion, flash, combustion 49
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protect feed pumps against reverse rotation 52
Reverse flow through a feedwater pump can cause severe damage. Find out how you can protect your pump.

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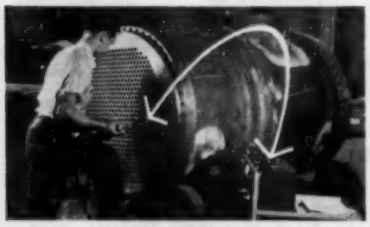
CUT COST up to 30% with AIRE-TOOL

With AIRETOOL'S all-electric tube expansion control, manufacturers and fabricators report savings of up to 30% in production time and labor costs on precision rolling and accurate expansion of condenser and heat exchanger tubes, over manually controlled methods. With this precision method, even the most inexperienced operator can roll uniform, tight tube joints in greatly less time, with no danger of injury to the tube sheet, tube ends, or distortion of tube ligaments. Remember too, that there's a dependable AIRETOOL Expander for every tube size and tube sheet thickness, large or small. Self feeding and parallel rolling, AIRETOOL'S ball bearing thrust collar eliminates frictional heat, while the taper and roll of the tube expanders produce uniform expansion with no sharp offset inside the tube.



For an "On Your Job" demonstration of AIRETOOL'S Tube Expansion Control System, contact your nearest AIRETOOL representative, or write, wire or phone the AIRETOOL Mfg. Co., 318 S. Center St., Springfield, Ohio.

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Circle 129 on READ-N-CIRCLE card

nuclear news

. . . about industry & power

MORE REACTORS

Spain is buying a 3000-kw reactor for installation near Madrid from the General Electric Company . . . . Brazil has ordered a "swimming pool" reactor from Babcock & Wilcox . . . . Florida's three largest electric utilities are planning a major power plant using atomic energy for fuel. Allis-Chalmers and Babcock & Wilcox have signed with Florida Power & Light, Tampa Electric, and Florida Power Corporation with 1962-63 as target date.

PACKAGE, ATOM-FIRED BOILERS ON THE WAY

Compact, package, atom-fired boilers producing economical steam, heat, and hot water for industry may be only a few short years away. Spokesman for Orr & Sembower says "now that the government is moving ahead with the design of packaged atomic power for planes and ships, and increasing the availability of atomic energy to industry, we expect the atom-powered boiler to emerge quickly from the drawing board to industrial applications." . . . Design features of a 10,000-kw single-cycle boiling water reactor were disclosed to the recent American Power Conference by General Electric. Design of this plant covers the range of 10,000 to 50,000 kw. Estimated cost of power from the new reactor is approximately 15 to 20 mils/kwh. GE expects that tests on this initial plant "will be of material assistance to us in developing a whole family of small power plants, of which the 10,000-kw plant is the forerunner."

INSURANCE PROBLEMS GET SPOTLIGHT

Three groups comprising an insurance syndicate say they are ready to accept risks totalling more than $500 million. Two organizations are being formed, one to provide property insurance and the other to provide liability insurance . . . . Preliminary report of the Legislative Drafting Research Fund of Columbia University, recommends that vital national interest in rapid development of atomic power demands that resources of the federal government be added to those of private insurers who cover nuclear reactors . . . . Two-day seminar on problems of indemnification against reactor hazards was conducted by the Joint Congressional Committee on Atomic Energy. Senator Clinton P. Anderson termed the meeting "a most constructive hearing." . . . Ten insurance executives studying problems in insuring private operation of reactors and other atomic energy

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Consulting is a full time job, too!

In our continuing efforts to engineer sound water conditioning for industry, our service activities extend into many phases of this exacting field.

The Betz Consulting Division, for example, is typical of the completeness and diversification of the service we offer.

This separate unit of the organization, staffed with qualified chemical, mechanical and sanitary engineers, provides full-scale engineering services on a variety of problems relating to the *external* conditioning of industrial water for process, cooling, and boiler feed requirements, and the treatment of industrial waste and sewage.

Whether the water or waste problem is of broad or limited scope, the Betz Consulting Division matches *service* to *need* through its many activities such as

. . . economic and technical surveys . . . chemical engineering research . . . pilot plant design and operation . . . equipment specification and procurement . . . process design and supervision . . . start up operation . . . continuous supervisory service.

This specialized consulting service is *another* reason why Betz continues its leadership in providing completely-integrated engineering on all water problems.

Ask a Betz District Engineer the next time he calls how Betz Consulting Service can help you solve *your* water problem. He'll be happy to provide the details.

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CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

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are available in all sizes—for every conceivable purpose!
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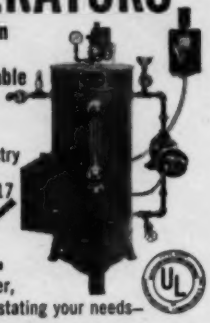
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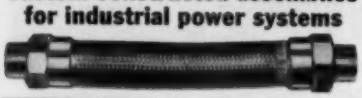

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nuclear news

. . . starts on page 6

facilities have released a report on their study for the AEC indicating that the most difficult problems in connection with the insurance on atomic energy installations lie in the field of third party liability.

NUCLEAR MEETINGS NUMEROUS

Tempo of the nuclear convention circuit is picking up. Pittsburgh section, ASME, just concluded a "shirt sleeve" conference on nuclear power plants. This meeting was billed as the first "to deal exclusively with the work-a-day problems of making atomic electric power a reality" . . . . Nonpower industrial applications of nuclear energy will be explored in Chicago on May 15 and 16 during a two-day meeting sponsored by Armour Research Foundation . . . . Over 400 leaders of atomic and mining industries, finance, government, and education, will meet in national conference in Denver June 25 and 26 under joint sponsorship of Atomic Industrial Forum and Denver Research Institute.

OVER 30,000 REPORTS REVIEWED FOR INDUSTRY

Special team of AEC reviewers has completed examination of 30,773 research and development reports in the stepped-up program to make more atomic energy information available to private industry.

NUCLEAR POWER DEMANDS BETTER WATER

In a review of two years' operating experience, two men from Westinghouse and one from National Aluminate report that "major innovations in water technology result, quite naturally, from the presence of nuclear radiation." Eight factors become important: (1) Radiation decomposes most materials in water or causes them to become radioactive, limiting use of additives for corrosion control; (2) Radiation increases tendency of fuel elements to foul with system corrosion products; (3) Radiation causes dissolved hydrogen and oxygen to recombine, providing built-in oxygen scavenger; (4) Radiation may radically alter pH of primary water, producing corrosion and fouling; (5) Radioactivity induced in piping hinders inspection; (6) Radioactivity monitoring of water is required; (7) Disposal of radioactive water, ion exchange resins, and backflush water must be provided; and (8) Radioactive samples must be handled for analysis.

Solve Distribution Problems
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"Packaged" Units for Indoor Installations

Speeds Expansion and Earlier Production. The Substation is shipped complete in one or more factory-assembled units, on a substantial steel base, completely wired and tested, ready for installation and final connection. This saves the extra expense of buying separately the transformers, switches, fuses, insulators, circuit breakers, and other accessories; thereby also saving the extra labor cost and trouble when assembling and connecting on the job.

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Saves Copper. The Substation can be placed near the load center, so that shorter secondary cables and smaller primary lines can be used. Improved voltage regulation and reduced line drop.

Reduces Costly Power Interruption. By locating the Substation at or near the load center, it restricts the power interruption to that area. Other areas, not affected, can continue operation.

Years of Continuous Hard Service. The rugged construction, liberal design, expert craftsmanship, sound engineering, all embodied in SORGEL transformers, have given years of continuous severe service.

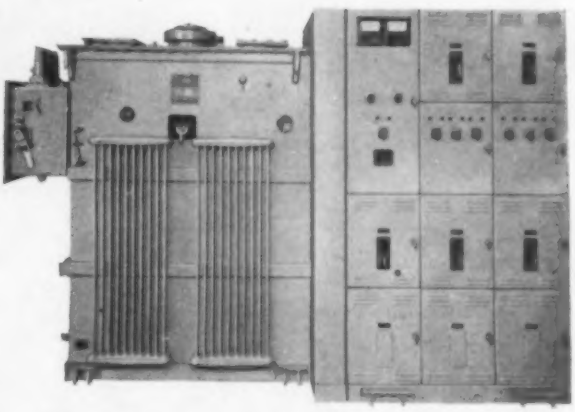
Types. Either dry-type or Askarel-cooled transformers are available with any type or make of switchgear, or from any substation manufacturer.

Engineered to meet your exact requirements

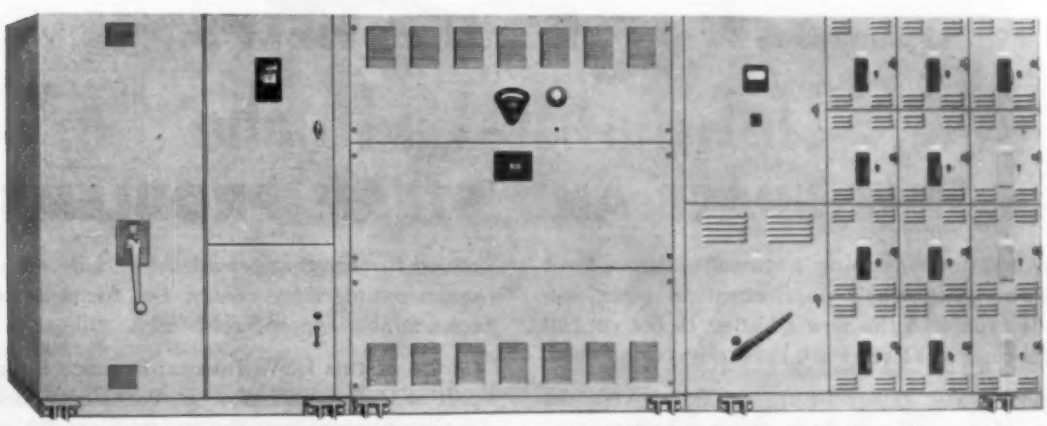
Not necessary to design or change your installation to fit a "standard"

Sizes up to 3000 Kva.
All voltages up to 15 KV.

SORGEL transformers are particularly adaptable for indoor installations; in hospitals, libraries, schools, institutions, office buildings, and other structures where low sound levels are an important factor.



500 Kva, 13,800 volt Askarel-cooled SORGEL transformer, with primary liquid filled switch, secondary meters, and circuit breakers.



2000 Kva 3-phase, 13,200 volts air cooled dry-type transformer, with primary switchgear, metering, and secondary breakers.

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40 years' experience in the development, manufacturing and application of transformers

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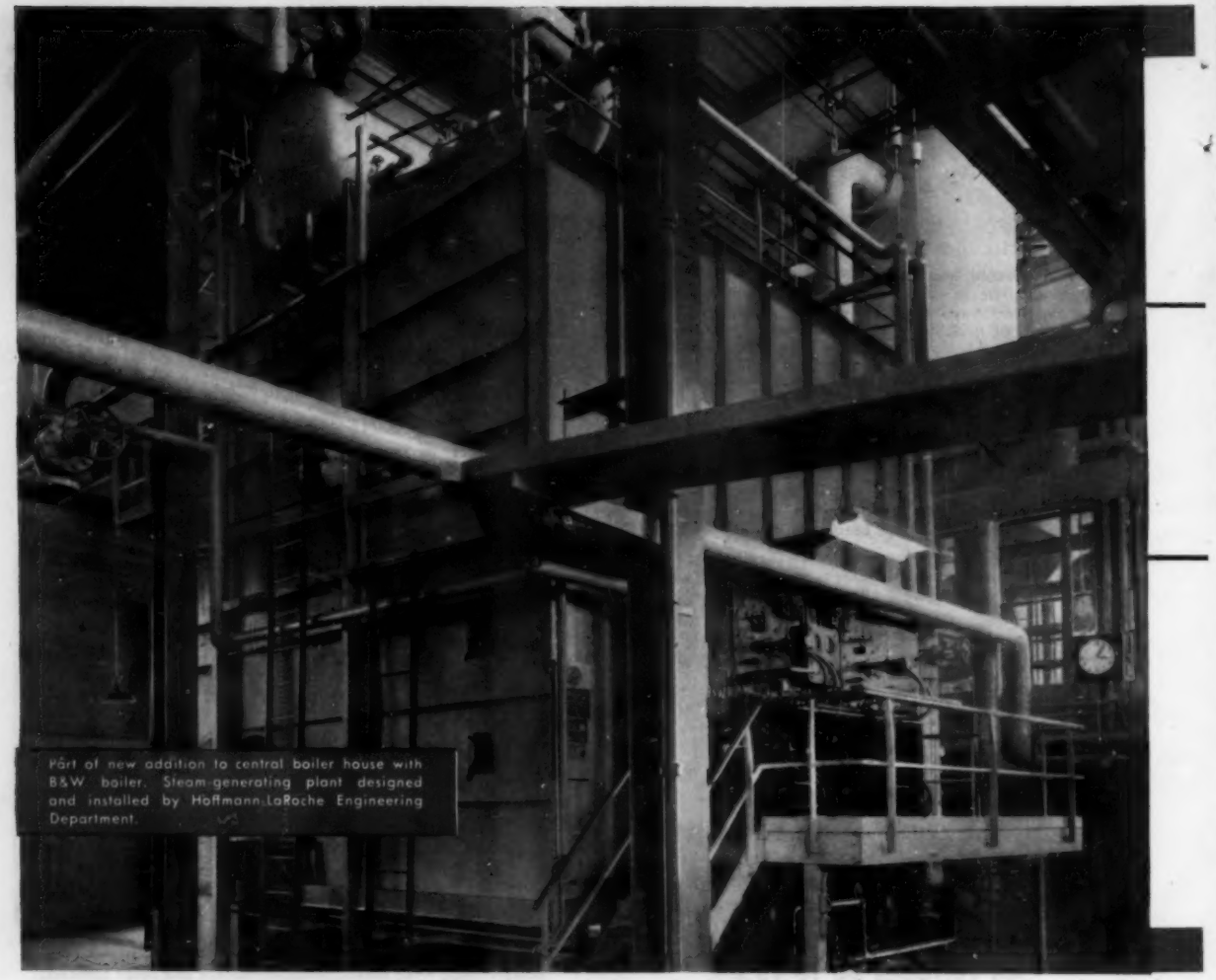


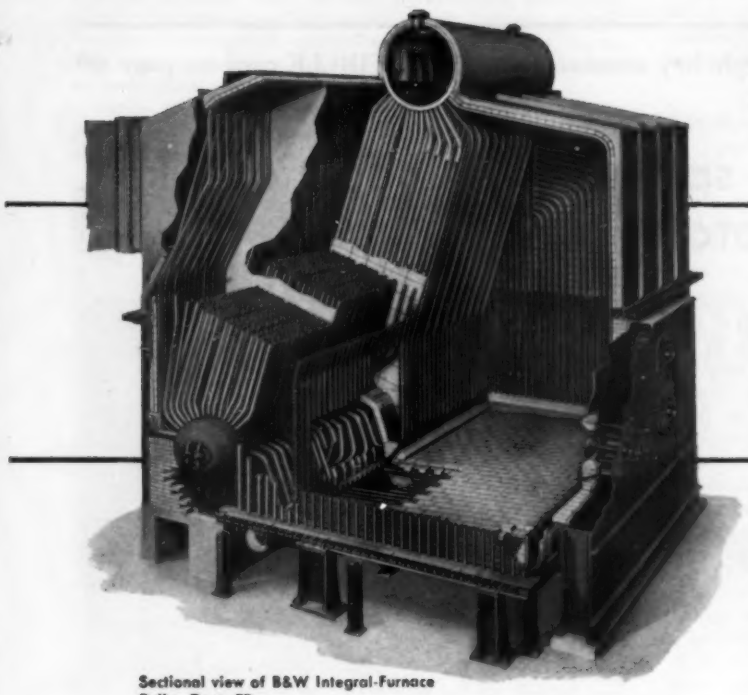
Part of new addition to central boiler house with B&W boiler. Steam-generating plant designed and installed by Hoffmann-LaRoche Engineering Department.

B&W FP BOILER HELPS Hoffmann-La Roche SOLVE SPACE AND STEAM PROBLEMS

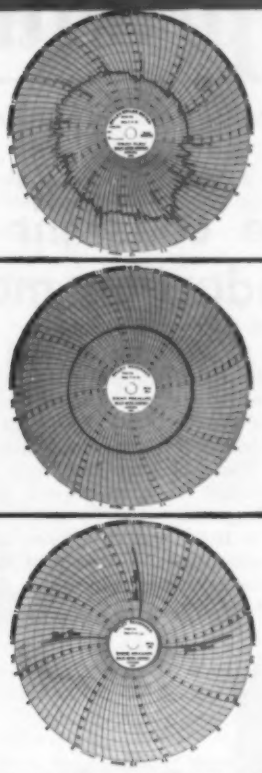
Spotless housekeeping, noticeable throughout Hoffmann-LaRoche's pharmaceutical plant, extends even into the new addition to the central boiler plant at Roche Park in Nutley, New Jersey.

A new B&W Integral-Furnace Boiler replaces four older, smaller and less efficient boilers, now on standby in another boiler room. This centralization of steam generation permits the company to more surely plan the use of that valuable space for expanding production facilities. The new boiler is oil-fired and has a design capacity of 75,000 lb. of steam per hr. The unit has a completely water-cooled furnace that provides durability and eliminates maintenance common to furnaces having considerable exposed refractory.

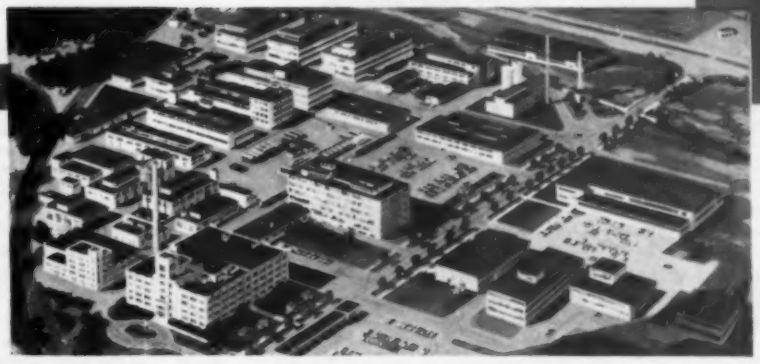
Choice of this B&W Integral-Furnace Boiler, as part of Hoffmann-LaRoche's continuing modernization program, was the result of careful weighing of all factors involved in the heating and processing operations. The program required additional dependable steam on tap in sufficient quantities at all times. Then, too, wide load swings have to be handled smoothly and economically. The B&W Boiler does this under complete auto-



Sectional view of B&W Integral-Furnace Boiler Type FP.



Steam flow, pressure, and smoke charts indicate handling of variable loads at constant pressure with a clean stack.



ROCHE

matic control, providing peak efficiency over the load range. An indication of the quick response and flexibility of the boiler in handling the load swings is indicated by the charts.

Like so many other companies of all kinds, where steam is required – for processing, heating, hot water, air conditioning – Hoffmann-LaRoche has selected an efficient B&W Boiler that precisely meets its needs for reliable, economical steam, and is backed by a policy of reputable service that assures complete satisfaction. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

BABCOCK & WILCOX

BOILER DIVISION

G-770

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Part of new addition to central boiler house with B&W boiler. Steam-generating plant designed and installed by Hoffmann-LaRoche Engineering Department.

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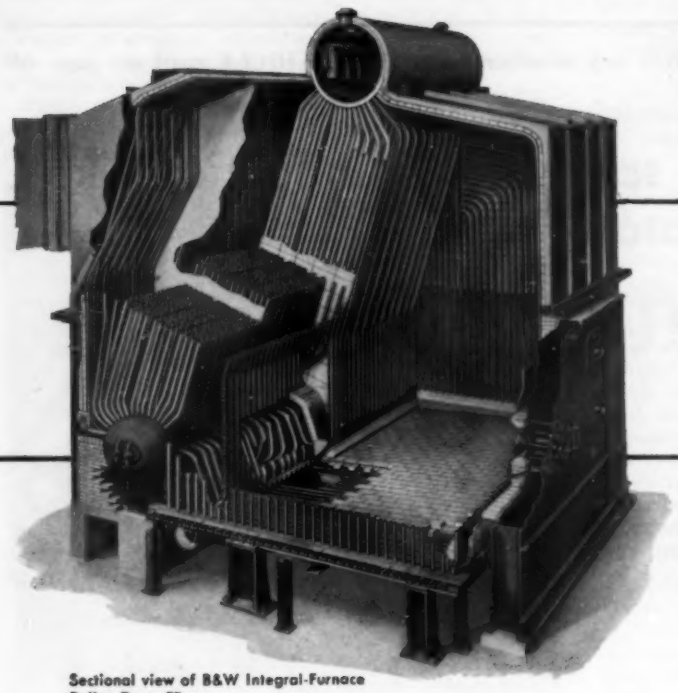
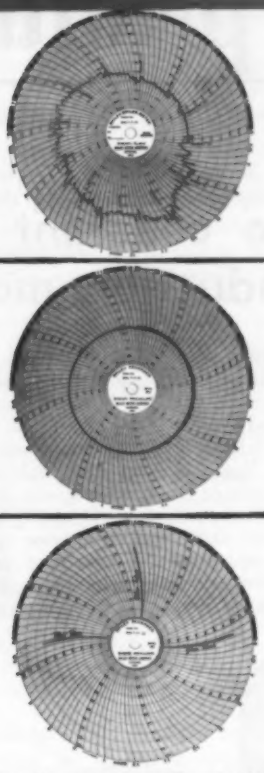


Sectional view of B&W Integral-Furnace Boiler Type FP.



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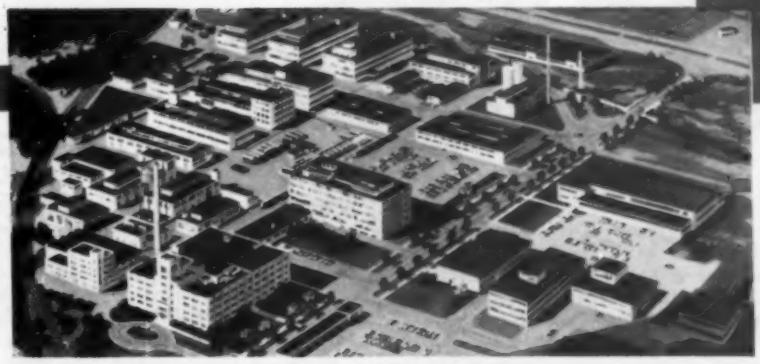

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BOILER DIVISION

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new products

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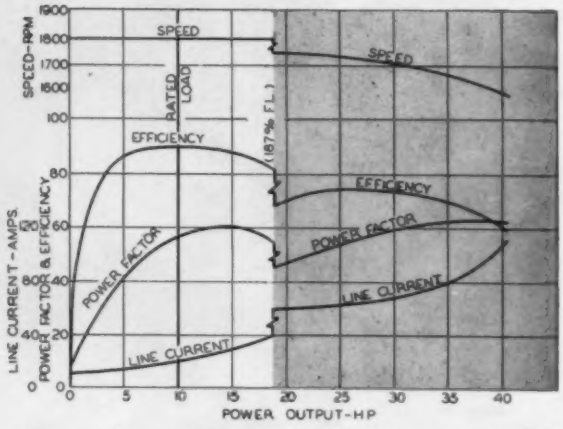
700-True constant speed with induction-like Synduction motor

Truly constant-speed motor combining speed regulation of synchronous motor with rugged simplicity of induction motor has been announced in sizes from ¼ to 40 hp. Regardless of load (within limits of pull-out torque) and voltage, the Synduction motor maintains absolutely constant speed. Speed is determined only by frequency of the stator voltage. To change speed, frequency must be changed. Frequencies from 10 to 300 cps have been used. Speeds up to 10,000 rpm have been achieved.

Secret of the Synduction motor is design of the rotor cross section, which obstructs quadrature-axis flux and simultaneously maximizes direct-axis flux. Die-cast rotor is interwoven with aluminum to direct rotor flux flow. This gives the synchronous-motor-like constant-speed characteristic without resorting to dc excitation, slip rings, exciters, commutators, and brushes usually associated with synchronous machines. Every part aside of the rotor in the Synduction motor is a stock item for ordinary induction motors.

Synduction motor stator is same as ordinary induction motor. Novel rotor is secret of constant speed ability.



Important feature of Synduction motor is constant speed (top curve) throughout entire load range (white area).

COMPARISON OF TYPICAL MOTOR CHARACTERISTICS
20 hp, 1800 rpm, 60 cps, 3-phase

	Synchronous Motors		SYN-DUCTION MOTORS	Induction Motor	Reluctance Motor
	100% pf	80% pf			
Efficiency	88	87	88	88	79
Power factor	100	80 (lead)	60 (lag)	88 (lag)	38 (lag)
Pull-out torque	150	200	175	...	150
Pull-in torque*	110	125	120	...	80 100
Locked-rotor torque	110	125	280	150	400
Locked-rotor amperes	675	600	975	575	1050

*Based on 8 lb-ft² load inertia

Application of the hybrid Synduction motor is most promising in sizes below 40 hp where the constant-speed performance of a synchronous machine is to be combined with the low first cost, rugged construction, operating simplicity, and easy maintenance of the induction motor. Principal categories of application are

- where the motor must operate at constant, unvarying speed
- where several motors must operate at a fixed ratio of speed of one motor to another
- where the speed of a motor, or group of motors, must be adjustable over a speed range with minimum variation at any speed

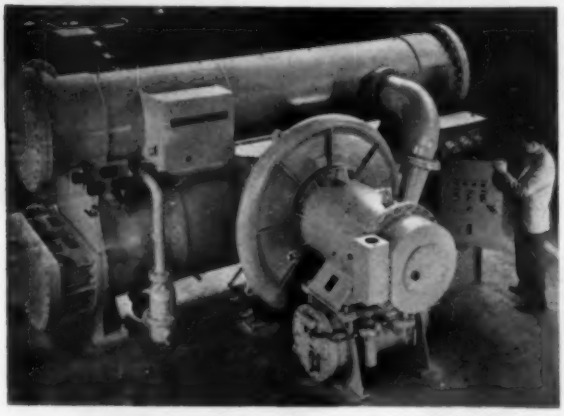
Synduction motor may be considered a variation of a synchronous reluctance motor. Synduction motor starts and accelerates like an induction motor. As slip decreases, induction motor torque pulls the rotor into synchronism, load inertia permitting. If pull-out torque is exceeded, Synduction motor reverts to induction-motor-like operation.

An electromechanical drive has been developed to supply variable frequency. Standard across-the-line starters are the only starting control needed. At present, individual Synduction motors are engineered for individual applications. Data needed are load inertia, starting time, electrical supply characteristics, speed range, enclosure, and other such data as may affect design. Off-the-shelf models are expected soon. ALLIS-CHALMERS MANUFACTURING COMPANY.

701-Refrigerating machine is hermetically sealed

Single-stage hermetic centrifugal refrigerating machine features quieter, more efficient performance and completely automatic chilled-water temperature control. Compact construction eliminates extra impellers, housings, and connections — saves space and weight as well as installation and operating costs.

Single impeller is mounted directly on motor shaft, eliminating field alignment of rotating parts. Unit consists of three major components (evaporator, compressor,



and condenser), and may be installed by four men in a week. Variable inlet guide vanes automatically regulate the quantity, velocity, and direction of refrigerant gas flow to the compressor in direct response to cooling load requirements. Direct-acting thermostat in the chilled-water exit pipeline controls guide vane position. This allows no-load starting and no-load condition for the drive motor when cooling load is zero. Electric interlocked controls insure proper operating oil temperature and pressure. AMERICAN BLOWER CORPORATION.

702-Heat-resistant brick speedily solves flooring problems

Versatile new heat-resistant brick withstands effects of heat and thermal shock. Provides speedy means of placing heavy duty floor that can withstand high temperatures and severe thermal shock without inherent problems encountered in curing calcium aluminate cement. High-temperature heat-resistant brick outlasts paving brick in many instances. "Emeri-Brick" withstands sudden thermal shock of being covered with molten iron, followed by sudden quenching with cold water. Heat-resistant brick is laid essentially the same as ordinary brickwork — no special tools are required. WALTER MAGUIRE COMPANY, INC.

703-Lightweight thermal switch acts fast

New thermal switch available for applications where fast-acting, sensitive, thermally responsive regulation is required for control of dangerously high or low temperatures. Weighs less than 1 ounce. Has an operating differential of plus or minus only 1 degree with extremely fast response. Has an effective calibration temperature rating from −20 F to +1000 F. Will continue to operate accurately within its rated capacity even when subjected to momentary overshoots of 1000 F beyond its rating (that is, 2000 F). Will also operate without injury on undershoots to as low as −80 F. Electrical rating is 1½ amperes at 28 volts dc resistive. Switch body is grounded to mounting and one wire connected to the head. All-welded corrosion-resistant construction (no brazing) and furnished with normally open or normally closed contacts. CONTROL PRODUCTS, INC.

704-How to permanently patch perforations in process piping

New, unique tool repairs leaks quickly, permanently and economically. Tool consists of pipe clamp gaskets, and patches accurately shaped to fit specific pipe sizes and to assure skin-tight fit when gasket is compressed. Patches are steel, with either neoprene or asbestos gaskets. Patch may be welded to pipe immediately, or left on pipe until welding is convenient. Permanent patches are as strong as the pipe itself and have been tested to 6000 psi. Cold-weld process permanently welds patch to pipe without use of welding equipment. After clamp is removed, patch becomes integral part of pipe. Patches applied by this method have been tested to 2000 psi. Special patches and gasket material can be obtained on order. ATLAS INDUSTRIES, INC.

705-Rubber-tired engine speeds switching

Rubber-tired switch engine that climbs across railroad tracks, travels on city streets, and pulls freight cars like a locomotive has been developed for the Pennsylvania railroad. Powered by a six-cylinder, 208-hp diesel engine, switching unit develops 30,000 ft-lbs of tractive effort — equal to a 50-ton conventional switch engine. "Switchmobile" pulls or pushes with equal power and speed in either direction, and handles gross weight of more than 1000 tons from standing start. Unit has a four-speed transmission for both forward and reverse travel.

Compressed air from 33-cu ft compressor supplies train braking system and Switchmobile's steering and breaking. It is only slightly longer from coupler to coupler than a standard passenger automobile. "Switchmobile" travels with equal ease on streets, roads, or even across open fields at speeds up to 16 miles per hour. Has four-wheel drive, AAR standard "E" couplers and air-brake lines both front and rear. Flexibility of this unit will result in faster pickup and delivery of rail-delivered fuel for industry and power plant use. LE TOURNEAU-WESTINGHOUSE COMPANY.

(more new products on page 14)

new products

. . . just circle key numbers on READ-N-CIRCLE card on page 69

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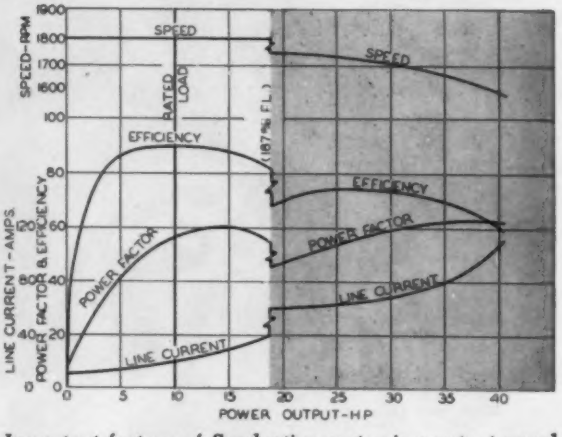

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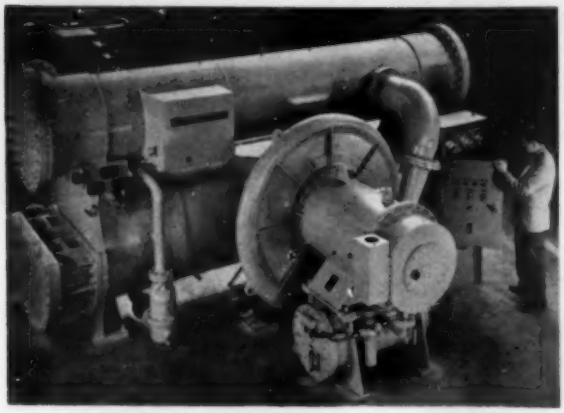

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(more new products on page 14)

new products

. . . starts on page 12

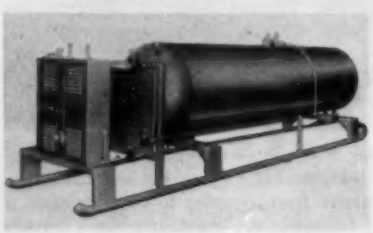
706-Rust preventive spray can be carried in pocket

New rust preventive spray that can cover approximately 80 square feet is packaged in a 12-ounce Aerosol spray container. Forms a clear, dry, waxy film to a thickness of 0.0005 inches. Protecting film need not be removed when equipment is returned to use

except in the case of precision instruments. Submersion tests in salt water and other liquids indicate that the product will give protection for tools, dies, and metal surfaces in storage. INDUSTRIAL MARKETING SERVICES CO.

707-Portable propane plant provides standby

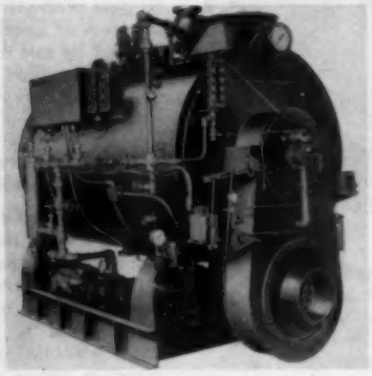
Package plant supplies propane gas for heating and other industrial uses. Primarily a standby unit, the plant is used when normal gas supply is cut off. Vaporizer, tank, and controls are



mounted on heavy metal skids. Controls are arranged so that standby unit can be quickly substituted for the main gas source when the need for a quick, emergency fuel source arises. SUBMERGED COMBUSTION COMPANY OF AMERICA, INC.

708-Compact steam generator cuts required space by half

Marine steam generator adapted to industrial use delivers 5000 lb/hr and occupies only 56 square feet of floor area. Boiler is seven feet high and delivers 150 hp in less than half the space required for an average package steam generator. Complete electronic controls give modulation control over an extremely wide range with exceptionally high efficiency.



Unit is factory assembled with oil pump assembly, water treatment tanks, and accessories side-mounted to obtain maximum use of space. CYCLOTHERM DIVISION, NATIONAL-U. S. RADIATOR CORPORATION.

709-Miniature electric eyes lick tough measuring problems

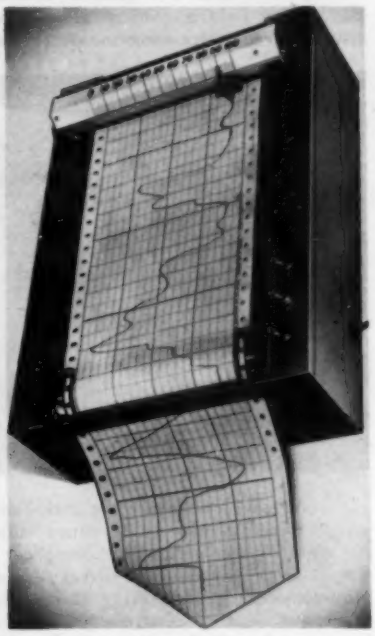
Miniature electric eyes solve many problems when there is need to count, monitor, control, inspect, protect, position objects in transit. Mount on ¼-in. pipe fittings for direct connection to conduit. Light source throws beam across critical gap to photo unit. Adaptable to close assemblies for accurate measurements of interrupted or reflected light. Operate on a 110-volt, 60 cps current. Minimum time of light cutoff for passing objects is 1/30 second. Permits accurate control in minimum space. ESS INSTRUMENT COMPANY.

FREE INFORMATION

For detailed free information on these products just circle the key numbers on the READ-N-CIRCLE card on page 69.

710-Strip chart recorder is portable, economical

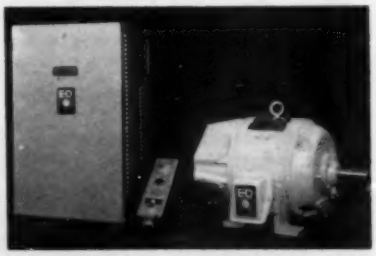
Portable, strip chart recorder that operates on a self-balancing potentiometer principle is portable and economical. With appropriate sensing devices, it will record temperature, speed, light, pressure, resistance, motion, or any variable that can be rep-



resented by a dc millivolt signal. Recorder features rectilinear tracings, 100 mv full scale deflection, high input impedance, excellent reproducibility, 1 percent accuracy, and high torque. C. H. STOELTING COMPANY.

711-Variable-speed drive is exceptionally flexible

New variable-speed drive offers wide speed range, compactness, close speed regulation, and easy maintenance. Normal speed range is 22:1, but speed ranges as great as 60:1 are possible. Standard optional features



include dynamic braking, reversing, and inching control. ELECTRO DYNAMIC DIVISION, GENERAL DYNAMICS CORPORATION.

(more new products on page 16)

Seven Products Replace Twelve. Sun representatives show how Sun's plan of industrial lubrication and preventive maintenance benefit management.

Over 70% of all plant equipment is now lubricated by only two moderately priced oils.

How A Sun Engineer Helped Cut Lubrication Costs by 15%... Reduce Oil Inventory by 42%

Maintenance Is Easier. Sun's plan helps prevent mistakes... reduces chances of applying wrong lubricant.

For years, department foremen of a large folding box plant purchased "special" lubricants to meet individual needs. Throughout the plant, a total of twelve products were being used...some extremely high in price.

The man from Sun called management's attention to this fact. He pointed out that much of the plant equipment, although different in name and function, was mechanically the same. He proved that over 70% of the equipment could be lubricated by two products instead of several lubricants basically alike.

Today, as a result of Sun's recommendations, "special" lubricants are gone; costs of lubrication are down 15%; and, oil inventories are reduced by 42%.

For the full story about how Sun can simplify lubrication setups and save on oil costs...see your Sun representative or write SUN OIL COMPANY, Philadelphia 3, Pa., Dept IP-5.

SUNOCO

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY

PHILADELPHIA 3, PA.

IN CANADA: SUN OIL COMPANY, LTD., TORONTO AND MONTREAL

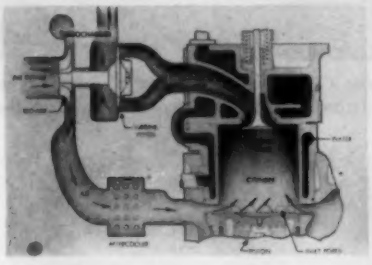
Circle 126 on READ-N-CIRCLE card for more data

new products

. . . starts on page 12

712-Exhaust-driven turbocharger offers increased power

New design principle gives exhaust-powered turbocharging from startup through full load. Principle incorporates timed exhaust valves that open to generate pressure pulse, that in turn, moves turbine blades. Cam-operated exhaust valves permit early opening to completely evacuate burned gases, and controlled closing to trap



maximum supercharging air. Chain-driven timing system, coupled with pulse-generator ignition, results in higher efficiency and lower maintenance. Design results in smoother combustion characteristics due to timing arrangement, and exhaust manifold. WORTHINGTON CORPORATION.

713-Abrasive cleaning tool removes its own dust

Lightweight, self-contained abrasive cleaning tool provides complete recovery of abrasive and dust. Efficient cyclone gathers dust into attach-

ed bag and permits abrasives to be reused. Single ½-inch air line connection permits use inside tanks, on ceilings, and for many single-man operations. CLEMENTINA LTD.

714-Heat-resistant fiber comes in rope form

Aluminum-silicate ceramic fiber withstands heat as high as 2300 F. This lightweight resilient fiber, now available in rope form, is especially

useful as expansion joint packing and high-temperature caulking. May be used also as insulator wrapping and for high-temperature gaskets and seals. Ceramic fiber is chemically inert and unaffected by most furnace atmospheres including hydrogen. THE CARBORUNDUM COMPANY.

715-Manual pressure oiler gives positive lubrication

Positive pressure, self-contained oiling system delivers oil to all points on all types of equipment. It is the answer to lubrication in hard-to-reach locations. Oil supply is always visible. Six outlet distributors permit lubrication to bearing points as far

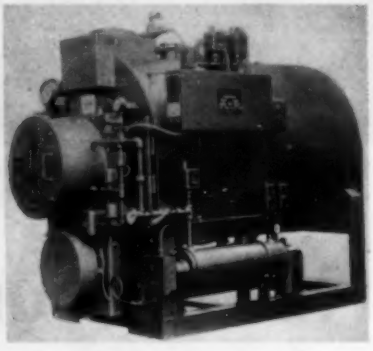
FREE INFORMATION

For detailed free information on these products just circle the key numbers on the READ-N-CIRCLE card on page 69.

as 100 feet away. Reduces lubrication shutdowns and hand oiling hazards. Permits greater safety of operation by eliminating dangerous hand-oiling. Also eliminates possibility of missing or forgetting to lubricate bearings in inaccessible locations. Feeds right quantity of oil through individual feed tubes to all bearings simultaneously with each stroke of the pump. TRICO FUSE MFG. CO.

716-Package boiler fits limited space

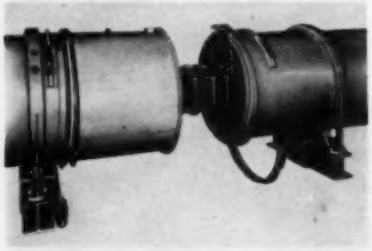
New, package automatic boiler small enough to fit where space is limited, handles up to 50-hp requirements. Boiler measures 7 ft 2 in. long, 3 ft 4 in. wide, and 5 ft 2 in. high. Clearance of less than 4 ft from both front and rear doors is all that is required for tube removal. Fully assembled unit is equipped with burner, boiler trim, automatic controls, Fiberglas insulation, and metal jacketing. Can be supplied to burn light oil,



No. 5 oil, or gas. Combination units that burn either gas or No. 5 oil or lighter can also be supplied. Burner is a forced draft-type, designed to fire any of these fuels. Quick change-over can be made from one fuel to another. BOILER ENGINEERING AND SUPPLY CO., INC.

717-Isolated bus conducts high voltages safely

All-welded, aluminum, factory-fabricated isolated phase bus is now available. Easy opening for inspection is gained from a new two-way sliding cover with V-clamp closure. Completed structure has smooth inside



surfaces, eliminating pockets that collect moisture. Normal mounting conditions permit use of two supporting rings for each basic assembly, giving both extreme rigidity and quick alignment. Structures have smooth inside surfaces to prevent moisture deposition and corrosion. I-T-E CIRCUIT BREAKER COMPANY.

718-Hydraulic pipe bender needs only one setting

Pipe bends up to 90 degrees can be made in one setting of the pipe and one stroke of the ram with the new S-130 One Set hydraulic pipe bender. Bending frame, swivel, and bending shoes are made of rigid, lightweight aluminum for greater portability, easier assembly and maneuverability. Removeable top plate permits easy setting of the shoes and positioning of the pipe for bending. By moving this top plate, pipe can be simply inserted from the top. Bending job accomplished without usual loss of time

for sliding pipe in from side—a useful feature when working in congested areas. Bender will work in any position—on the floor, bench, or overhead on existing runs. Unit features special angle gauge giving operator visual control of progress of bend with every pump stroke. BLACKHAWK MANUFACTURING COMPANY.

719-Compensated circuit breaker has wide temperature range

Ambient compensated circuit breaker is designed for 120-volt ac lighting and power distribution panels. New breaker eliminates tripping due to ambients varying between 30 and 140 F. Compensation is provided by unique bimetal element that permits

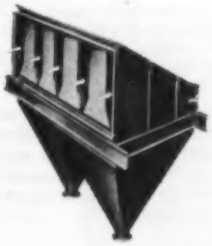
full-rated load through wide temperature variation. Breakers are supplied in full range from 15 to 50 amperes. FEDERAL PACIFIC ELECTRIC COMPANY.

(more new products on page 18)

Your plant and equipment suffers . . . your community goodwill fades away. These problems can be solved. Prat-Daniel Collectors are designed for the control of industrial dusts and flyash. Multiple small diameter tubes provide powerful centrifugal forces, resulting in sustained high collection efficiency . . . even with ultra-fine dusts.

Whether the problem is industrial dust or flyash, you are assured of satisfaction with P-D Collector Systems, engineered to meet your specific needs.

Write for Reprint No. 102 titled, "What Type Collector?"



pd

Project Engineers
THE THERMIX CORPORATION
GREENWICH, CONN.
(Offices in 38 Principal Cities)
Canadian Affiliates: T. C. CHOWN, LTD., Montreal 25, Que.

Designers and Manufacturers
PRAT-DANIEL CORPORATION
SOUTH NORWALK, CONN.
POWER DIVISION: Tubular Dust Collectors, Forced Draft Fans, Air Preheaters, Induced Draft Fans, Fan Stacks

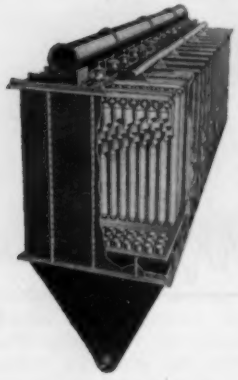
Circle 102 on READ-N-CIRCLE card for more data

Norblo solves dust problems

Whatever you need in dust or fume control, be sure to check *Norblo*

In Bag Type, Centrifugal or Hydraulic dust collecting systems, Norblo Dust and Fume collection equipment has many design advantages. These three types, frequently used in certain combinations, provide economical dependable control as required in smelting, rock products, chemical, milling and processing fields.

What is the best approach to your dust problems? Norblo helps you select—applies engineering skill and "know how" gained in first hand experience of over 40 years in many industries.



Norblo Bag Type Systems

Automatic and Standard

For continuous or heavy duty service providing very high efficiency at very low cost of operation and maintenance. Basic unit contains 78 bags, 6" diameter, 8' 3" long. Air flow is upward, from inside, thus keeping bags fully distended. Total free cloth area per compartment 936 square feet. Shaking and cleaning controlled by electric timer, is cyclic, one compartment at a time, each having its individual compressed air shaker mechanism and the whole system variable and adjustable for dust load without shutting down . . . Also Norblo Standard Bag Type (non-automatic).

Norblo H. E. L. S. Centrifugal Systems

A cyclone or centrifugal type collector for all materials, from sawdust to fly ash; characterized by high efficiency of collection with low static drop. The Norblo H. E. L. S. has no internal vanes, gadgets or dampers. High efficiency is obtained by scientific proportioning and by the patented (No. 2,259,919) expanding nozzle. These design features eliminate the power-wasting back eddy. Built in standard sizes with capacity up to 37,500 cfm.

Norblo Hydraulic Systems

A high efficiency, wet type collector, for separation of dust mixed with smoke or fumes. In most installations the Hydraulic unit is used with a Norblo Cyclone collector, thus reducing the amount of wet sludge to be handled. No moving parts. Filter beds are coke or high-fired ceramic tubes, light weight and kept in motion by ascending air stream. Beds are self-cleaning. Built in standard sizes with capacities up to 26,000 cfm.

Take advantage of the efficiency and low maintenance available through Norblo Equipment in these three proved systems of dust and fume collection. Write for full information.

The Northern Blower Company
6422 Barberton Ave., Cleveland 2, Ohio • OLympic 1-1300

Norblo ENGINEERED DUST COLLECTION SYSTEMS FOR ALL INDUSTRIES

Circle 100 on READ-N-CIRCLE card for more data

new products

. . . *starts on page 12*

720-Heat flow monitor in compact portable unit

Portable heat flow monitor reads, directly in Btu's, heat flow with a disc. Core of instrument is this disc, which has unusually high output of 250 mv/Btu/sq ft/hr. Useful for checking efficiency of structural, pipe, or window insulation, and determining heat-flow loss of refrigerated or heated areas. Disc, connected by 6-foot long leads to a plug-in resistance box, is a separate precalibrated assembly. NATIONAL INSTRUMENT LABORATORIES, INC.

721-Store utility cable with convenient cable reel

Heavy electric cable can be conveniently stored on new cable reel. When not in use, cable can be rewound and kept safely out of work areas and away from possible damage.

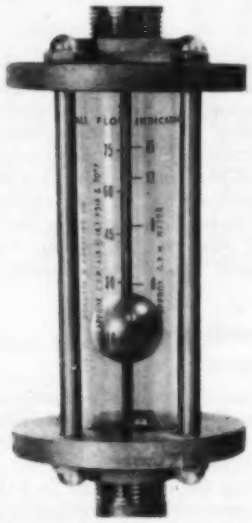
FREE INFORMATION

For detailed free information on these products just circle the key numbers on the READ-N-CIRCLE card on page 69.

Added cable protection is provided by rolled drum edges that prevent scuffing and cutting during both unwinding and rewinding. Reels are available for storing all types of hose and cable and can be provided with explosion-proof electric motor or geared hand crank. CLIFFORD B. HANNAY & SON, INC.

722-Flow indicator doubles in both liquid and gas

Ball-type flow indicator provides dual scale for measurement of water flow in gpm and air flow in cfm. Flow indicator, installed in tapered glass tube, indicates flow rate resulting



from force of moving liquid or air.

Indicator is all bronze, using guided float ball, and is carried in sizes from ¼ to 2-inch NPT sizes. SCHUTTE AND KOERTING COMPANY.

723-Transformer indicator keeps overload record

New overload indicator for conventional distribution transformers keeps a permanent and accurate record of overload hours based on copper temperatures. Helps predict transformer life, gives advance warning for change-out scheduling, and is easy to read. Unit consists of a control thermostat, a motor or timing

mechanism, and a signal light that serves as an auxiliary warning. When winding temperature drops, motor shuts off but indicator does not reset. It continues to show a cumulative total of number of overload hours. Dial will record a total of 300 hours of transformer thermal overload operation. WESTINGHOUSE ELECTRIC CORPORATION.

724-High-temperature castable withstands 3300 F

Monolithic, lightweight, high-temperature insulating castable gives trouble-free protection to costly furnace and kiln parts. Contains 96 percent aluminum oxide. Gives insula-

tion protection for temperatures up to 3300 F. Applications include back-up insulation for furnaces, high-temperature burner ports, waste disposal incinerators, and other high-temperature applications. NORTON COMPANY.

Pick INSTANTANEOUS HOT WATER HEATERS

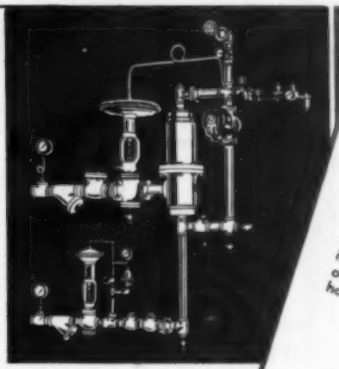
Pick STEAM INJECTION WATER HEATERS

ENGINEERED FOR SERVICE

Industries everywhere are replacing outmoded water heaters with Pick Instantaneous Water Heaters. Here are the reasons:

- ✔ HIGH OR LOW LOADS — Continuous or intermittent flow with negligible temperature fluctuation.
- ✔ WATER IS HEATED INSTANTLY. Entirely automatic, Water is heated in a flash to exact temperature by Steam Injection.
- ✔ FUEL SAVINGS ARE SUBSTANTIAL. No waste because water is heated only as used. Never stored and allowed to cool.
- ✔ NO STORAGE TANK REQUIRED. Compact design permits installations in out-of-the-way areas in corners, on walls or overhead. Saves valuable floor space.
- ✔ MAINTENANCE COSTS ARE LOW. Can be cleaned in a matter of minutes.
- ✔ INSTALLATION IS INEXPENSIVE. Only ordinary pipe connections are required.

PICK MANUFACTURING CO.
WEST BEND, WISCONSIN



Bendix Aviation Corporation
HAMILTON DIVISION

October 27, 1955

Pick Manufacturing Company,
West Bend, Wisconsin

Gentlemen:

The Pick Instantaneous Water Heater installed in this plant two years ago has solved most satisfactorily our problem of furnishing both continuous and also large intermittent requirements for hot water.

BENDIX AVIATION CORPORATION
Hamilton Division
D. R. Baird
Plant Engineer

SOLVED SMALL AND LARGE CONTINUOUS HOT WATER REQUIREMENTS FOR BENDIX AVATION CORP.

Other Industrial users are . . .

- United States Steel Corp.
- Ford Motor Co.
- H. J. Heinz Co.
- Bethlehem Steel Co.
- Wilson & Co.
- National Gypsum Co.
- National Aniline
- General Aniline

WRITE TO DEPT. IP-356 FOR BOOKLET ON HOW PICK HEATERS CUT COSTS OF HOT WATER.

Circle 109 on READ-N-CIRCLE card for more data

our readers write

. . . to industry & power

Provocative controversy

Gentlemen:

Your article in the March issue of INDUSTRY & POWER, titled "Oil Firing Soon Paid for Itself," proved very interesting, although we do not feel that the article is being quite fair to the coal industry because of the following.

The plant engineer is comparing new modern oil-burning equipment against outdated coal-burning equipment. If he would have spent $29,000 on modern coal-burning equipment to bring his plant up to date, we believe he could have showed a greater saving in operating costs than he has with his present equipment.

In this particular incident when he talks about using three men on a shift, two of these are coal passers in most instances. That being the case, by installing automatic stoker feeders, there would have been a savings made of two of these men, therefore effecting a greater savings with a smaller investment. This of course is the phase of the power plant that we are familiar with.

George L. Hager
President
Hager Bros., Inc.
Rockford, Illinois

Gentlemen:

We have been accustomed to reading your magazine for a good many years. We always were under the impression that we were reading a nonfictional, factual magazine. Unfortunately, however, we were rather shocked to find a considerable amount of fiction has entered into this particular article ["Oil Firing Soon Paid for Itself," March 1956] and we were wondering why a good editorial force such as you maintain would leave such fiction go by.

We refer particularly to the fact that somebody places a rotary oil burner on an old HRT boiler in which the unit probably has one-pass and the tubes are probably 4 inches in size and then the author claims 87 percent efficiency. Apparently the people who have been redesigning boilers, arrangement of heating surface, and improving oil burners in the past 10 to 15 years have been wasting their time when such efficiency as is indicated in this article is available for an old inefficient boiler. We do not believe anybody ever claimed an HRT boiler was efficient no matter how it was fired. We are amazed that such statements can be made in your magazine.

We would certainly like to have you take a look at this as we certainly do not want to feel we are on a mailing list receiving fictional literature when we are under the impression that it was a good trade magazine.

Paul J. Stein
Mechanical Equipment Co.
Pittsburgh, Pa.

Gentlemen:

It should be apparent to anyone that a comparison of fuels (as such) on delapidated old equipment with new installations is as fair as comparing two gasolines by using one in a poorly maintained Model "T" and the other on a modern V-type automobile engine.

The efficiencies you portray are due to conversion devices and not to fuel.

I hope an appropriate article correcting the manifestly unfair one referred to will shortly appear and justify our original confidence in your publication.

O. L. Scales
Executive Vice President
The Enos Coal Mining Company
Indianapolis, Indiana

Gentlemen:

We will be interested in your comments . . . [regarding] publishing this unfair comparison of an old stoker installation with a new oil burner installation.

Thatcher W. Rea
Secretary
Detroit Stoker Company

• *As we reported in our most recent Review and Forecast (page 53, January 1956), "Competition in fuels and firing equipment was never stronger." Still fiercely competitive, also as we reported, the foregoing letters reflect much of the comment we have received regarding this article.*

We have again verified the facts reported in our March story. We find them to be as valid as when verified prior to publication. Although this story shows that a modern oil-fired installation excelled an old coal-fired installation, it did not exclude the possibility that a modern coal-fired installation would similarly excel the old coal-fired installation. Our editors are working on several stories for future issues demonstrating the abilities of modern coal firing. One of these will appear next month.

Keen understanding

Gentlemen:

We have circulated among our membership the excellent editorial which appeared in your February issue. The piece was all the more gratifying because of the fact that it was unexpected. Your recognition and interpretation of coal's position with respect to atomic power is indicative of a keen understanding. . . .

America's energy needs for the future are such that all fossil fuels — coal, oil, natural gas — hydro nuclear energy, solar energy and whatever else may be developed, must be used most economical and most efficiently.

Again, I congratulate you on the editorial.

J. H. Cunningham
Director of Public Relations
National Coal Association

No hydraulic refresher yet

Gentlemen:

I am interested in receiving a set of the Electrical Refresher series as published in INDUSTRY & POWER. It is also my understanding that a hydaulic refresher was recently completed. If this is still available would you please forward a copy?

C. M. Jank
Hamilton Division
Bendix Aviation Corporation
Hamilton, Ohio

• *We recently completed a Thermodynamics Refresher, but have not run a Hydraulic Refresher as yet. We do appreciate the suggestion.*

Gentlemen:

In the January 1956 issue of INDUSTRY & POWER on page 38, reference is made to "two notable reports on operating techniques." We are interested in the second of these reports

which concerns integrated steam station control.

Will you please advise me regarding the name of the report, its author, and publisher. Also, please advise how I may obtain a copy of this article.

J. I. Hudson
Engineering Service Division
E. I. du Pont de Nemours & Company
Wilmington, Delaware

● *Report referred to is AIEE Paper No. CP 55-176, "Integrated Steam Station Protection." This paper was prepared by the AIEE Working Group on Steam Station Protection. A full copy can be obtained from AIEE, 33 West 39th Street, New York 18, N. Y.*

Forward to the authors

Gentlemen:

In the March 1956 issue of INDUSTRY & POWER magazine I read with great interest the article "It's Easy to Control Boiler Room Operation" by D. W. Karger, chief plant and industrial engineer of the Magnavox Company.

In our plant, we are going to inaugurate a program similar to the one that is used at Magnavox.

But to help us along we would like to obtain a copy of each of the different forms used for inspection and daily operation of boilers as outlined in Mr. Karger's article. Would you please relay this . . . . to Mr. Karger.

Lionel Tromlitz
Assistant Plant Engineer
Blue Lake Packers Inc.
Salem, Oregon

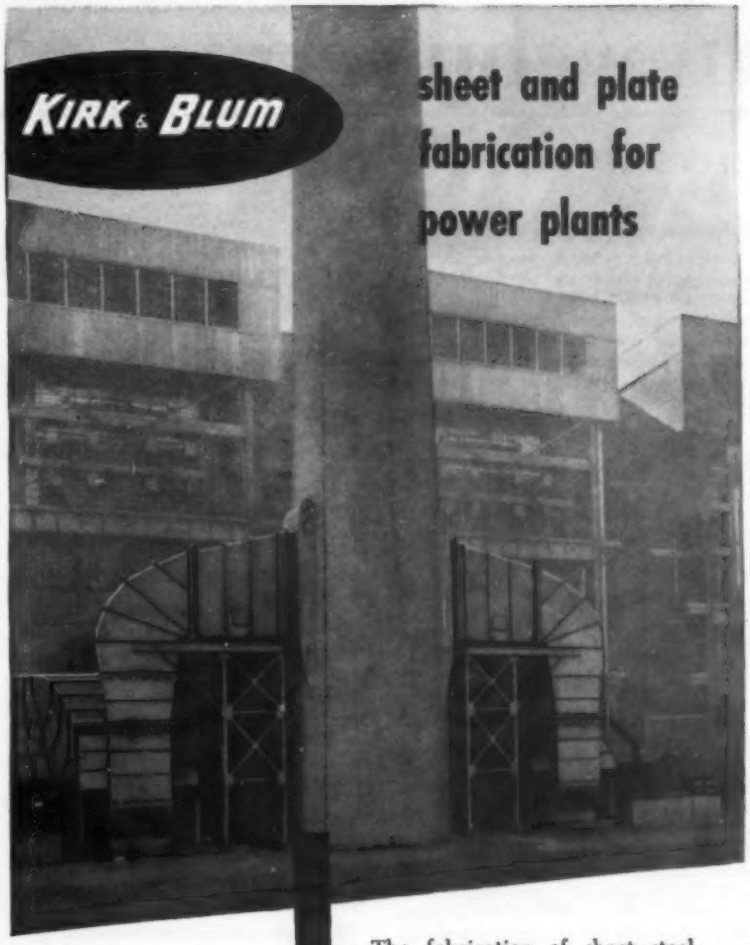
Gentlemen:

Referring to an article in your February 1956 publication by Messrs C. P. Muller, D. L. Aswell, and L. Maurin entitled, "Nearest Thing Yet to a Completely Automatic Power Station," I would be grateful if you could supply me with the manufacturer's name of the 36-point pressure scanner and recorder used at the Ninemile Point steam electric station.

I shall greatly appreciate any contact you could make between me and the above authors, as I am currently engaged with the C.E.I. in the solution of similar problems.

Guido Sartena
Mechanical Engineering Dept.
Cleveland Electric Illuminating Co.
Cleveland, Ohio

● *We are happy to forward readers' inquiries, such as these, to our authors.*



- breechings
- stacks
- air & gas ducts
- casings
- louvers
- bins & hoppers
- insulation jacketing
- control panels & desks

The fabrication of sheet steel and plate to exacting specifications has been a specialty of Kirk & Blum for 50 years. Exceptional experience and complete facilities for fabricating carbon steel, stainless, aluminum, monel and other alloys up to ½" thickness.

Send prints for prompt quotation or write for your copy of the latest Kirk & Blum Sheet and Plate Fabrication Booklet.

Whatever your requirements in sheet and plate fabrication . . . call on KIRK & BLUM.

THE KIRK & BLUM MFG. CO.
3174 Forrer Street, Cincinnati 9, Ohio

Circle 112 on READ-N-CIRCLE card for more data

new bulletins

. . . just circle key numbers on READ-N-CIRCLE card on page 69

400-Screw thread engineering data

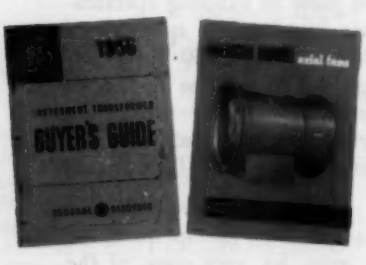
Engineering data for selection and application of screw thread fasteners are contained in this bulletin. Lists six common series of threads with recommendations for use. Defines terminology in screw thread selection and use. Twenty-four pages. NATIONAL MACHINE PRODUCTS COMPANY.

401-How to use gunned concrete

Where to use gunned concrete is explained in Bulletin 156. Original construction, restoration, waterproofing, fireproofing, and lining structures of almost any type can be easily done with gunned concrete. Lists equipment from ½- to 12-cu yd/hr capacity. Brings you up-to-date on this versatile construction material. Sixteen pages. AIR PLACEMENT EQUIPMENT CO.

402-Prevent over-running damage

Sprag-type clutches for over-running, indexing, and backstopping applications are contained in Catalog 103-C. Cross section drawings, application recommendations, and engineering data are contained for all units in the line. Includes basic installation and maintenance instructions and a wealth of information on direct-connected sprag-type clutches. Eight pages. THE FORMSPRAG COMPANY.



403-Transformer buying guide

Bulletin GEC-1028 contains all vital facts and figures on the company's instrument transformer line. Includes latest additions to the ever-expanding group of butyl-molded current transformers. Contains a wealth of engineering data. Eighty pages. GENERAL ELECTRIC COMPANY.

404-Axial fan and blower data

Axial fans for ventilation, process air supply, and process air recirculation are described in detail in Bulletin B-1013. Illustrates and describes tubeaxial and vaneaxial flow principles. Contains numerous selection tables and dimension installation drawings for direct-drive tubeaxial, direct-drive vaneaxial, and V-belt drive vaneaxial fans. Conversion charts list rectangular equivalents of round ducts. Thirty-six pages. AMERICAN BLOWER CORPORATION.

405-Telephones cut costs 10 ways

Ten ways to cut costs with inside telephones are described in Circular 1865. Lists examples of how typical business organizations have cut costs in their operations. Results in saving man-hours, breaks production bottlenecks, and helps employees accomplish more routine work. Twelve pages. AUTOMATIC ELECTRIC SALES CORPORATION.

406-Better industrial lighting

How you can improve industrial lighting at lower cost is described in this booklet. Summarizes eight basic advantages of using mercury vapor lamps in industrial plants. Contains specifications on five types of mercury vapor lamp for industrial uses. Includes comparison of lighting costs with both incandescent and mercury vapor lamps. Shows saving of $20 per year per lighting unit using mercury vapor lamps. Twelve pages. SYLVANIA ELECTRIC PRODUCTS, INC.

407-All about turbine-type pumps

Single- and two-stage turbine-type pumps are shown in exploded and assembled views in Bulletin 111. Illustrates how removable channel rings, spacer rings, and impellers may be replaced to place pump in like-new condition. Pump is made with either conventional stuffing box or mechanical seals. Eight pages. AURORA PUMP DIVISION, NEW YORK AIR BRAKE COMPANY.

408-Check your wiring capacity

New direct-reading instrument quickly shows if electric wiring will safely carry present or proposed loads. Bulletin PF-600 describes how meter shows directly the percent of voltage drop produced by any given load. Special circuit makes instrument self-calibrating for exact voltage concerned. Instrument eliminates calculations to determine wiring adequacy. Four pages. SPRAGUE ELECTRIC CO.

409-Need explosion-proof motors?

Explosion-proof motors meeting Underwriters' requirements for three common hazardous locations are described in this bulletin. Describes special moisture-resistant treatment for corrosive atmospheres, extra-long flame paths, and fully sealed, pre-lubricated ball bearings. Motors are available in standard, geared, or variable-speed models. Four pages. STERLING ELECTRIC MOTORS INC.

410-Remove water from air supply

"Air, water, and industry" discusses presence of water vapor in air, its destructive action, and proven methods for its removal. Animated, pocket-size text describes in nontechnical language necessity of removing water vapor from compressed air supply to eliminate problems caused by excess moisture. Twenty pages. VAN PRODUCTS COMPANY.

411-Centrifugal pump data

Bulletin 4011-A describes complete line of end-suction centrifugal pumps. Gives range from 1- to 5-inch discharge with capacities up to 1000 gpm at 75 feet head, and 100 gpm at 250 feet head. Includes performance tables, curves, and table of dimensions for all models in the line. A valuable reference book on centrifugal pumps for all engineers. Twelve pages. THE DEMING COMPANY.

412-Industrial control with Cypak

The "whys" and "wherefores" of static control systems are discussed in Booklet B-6584. Photographs, line drawings, and circuit diagrams discuss systems from four points of view: need for static control, what they are, how they operate, and where they can be used. Discusses how Cypak works, how it is

applied, and results that can be obtained from its use. Six pages. WESTINGHOUSE ELECTRIC CORPORATION.

413-Make best use of natural light

Outstanding light transmission and diffusion qualities of shadowproof glass fiber panels for skylights are described in Bulletin 12-j. Greater structural strength of heliarc welded aluminum frames assure maximum strength and durability. Skylight units require no maintenance, painting, or parts replacement, and are unbreakable under normal conditions. Eight pages. THE MARCO COMPANY.

414-Roller bearing data manual

Self-aligning roller bearings with capacities from 770 pounds to over 25,000 pounds are described in Book 2658. Includes complete engineering data on single-row, double-row, and pre-adjusted double-row bearings. One section is devoted to engineering and selection data including solutions to five bearing problems. Recommended addition to your engineering library. Eight pages. LINK-BELT COMPANY.

415-Underground piping manual

How to get the most out of your underground steam, hot water, and process piping is presented in Bulletin 56. Describes clay conduit structures and gives list of recommendations for different installations. Includes engineering data and specifications with available fittings. Provides information on preparing and installing armored clay conduit for all situations. Twenty pages. HEAT TRANSMISSION CONDUIT COMPANY.

416-Insert threads where needed

How to provide female insert threads in molded plastics, laminates, die-cast alloys, and in drilled holes without tapping is discussed in Bulletin 731. Includes size ranges available, installation techniques, and application chart. Gives complete line of sizes available with drill size dimensions for each unit. Four pages. HELI-COIL CORPORATION.

417-Incinerator uses smoke as fuel

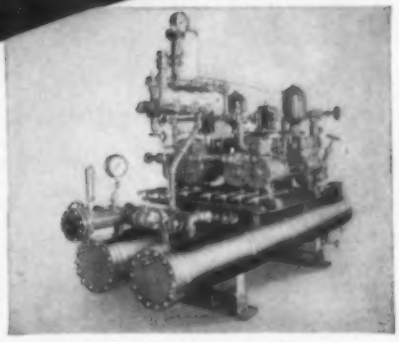
Read how incinerators are self-fueled. Bulletin contains operating information on all models. Units can also use gas or oil fuel. Four pages. BRULE INCINERATOR CORPORATION.

418-Nickel-lined pipe stops rust

Nickel-lined pipe, produced using a revolutionary plating machine and new techniques, is the answer to most corrosion problems. Pipe is available in sizes from 1½ to 24 inch id in random lengths. Bulletin discusses welding procedures. Describes how fabrication by welding will not affect adherence of the nickel plating. Lists many applications in all

Enco Automatic OIL PUMPING AND HEATING SYSTEM

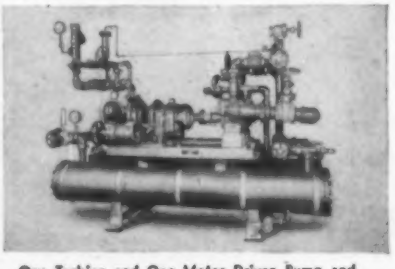
Completely Coordinated



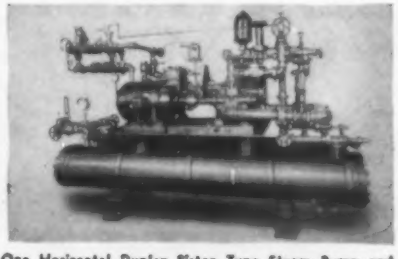
Two Horizontal Duplex Piston Type Steam Pumps and two fuel oil heaters—capacity 15 G. P. M. at 250 lb. pressure with either pump or heater.

Every detail part of an Enco Automatic Oil-Heating-and-Pumping Unit System is designed, assembled, checked and tested to make sure that it functions as an element of a completely coordinated unit. The sizes of pipes, fittings, valves and other elements are correctly proportioned for the efficient, dependable operation of the unit as a whole. All hand controls are visible and within reach of the operator for quick starting, stopping or cross-over reconnections between duplicate heaters and pumps. Adjustments and cleaning are similarly simplified.

Single or duplicate heaters and electric or steam-driven pumps are used. Interconnected duplicate units give full capacity with either pump or either heater. Capacities range from 100 to 5000 G. P. H. of heavy bunker oil.



One Turbine and One Motor Driven Pump and two fuel oil heaters. Capacity 30 G. P. M. at 150 lb. pressure with either pump or heater.



One Horizontal Duplex Piston Type Steam Pump and one Motor Driven Pump and two fuel oil heaters. Capacity 20 G. P. M. at 300 lb. pressure with either pump or heater.

BULLETINS ON REQUEST

OB-37 On oil burning, pumping and heating equipment.

OB-38 Instruction book on care and operation of oil-burner installations.

THE ENGINEER COMPANY

75 WEST STREET Enco NEW YORK 6, N.Y.

Circle 118 on READ-N-CIRCLE card for more data

new bulletins

. . . starts on page 22

phases of industrial piping. Includes information on nickel-lined fittings available. Eight pages. BART MANUFACTURING CORPORATION.

419-Valve is maintenance free

Straight-through flow, diaphragm valve described in Bulletin 101 is leakproof and maintenance free. Diaphragm bolted between valve body and cover prevents fluid contact with valve stem. Valve is available in sizes from ½ to 14 inches, threaded and flanged connections. Can be used in service up to 250 psi. Recommended for handling slurries, abrasive suspensions, and most hard-to-handle fluids. Four pages. STOCKDALE ENGINEERING COMPANY.

420-How to run rust ragged

How to get the most out of your rust-prevention maintenance painting is described in Bulletin 255. Includes outline for maintenance painting including surface preparation, paint mixing, application technique, and drying time. Lists advantages for use on wood, concrete, metal, and plaster. Multi-color illustrations depict laboratory tests as well as complete line of colors and numerous in-use examples. A recommended bulletin for all engineers, purchasing agents, and management concerned with maintenance painting. Twenty-eight pages. RUST-OLEUM CORPORATION.

421-Maintenance-free aluminum roof

Aluminum roofing and siding gives permanent, maintenance-free, all-weather protection for your plant. Complete discussion of new and unique industrial roofing sheet with salient features is included in this bulletin. ALUMINUM COMPANY OF AMERICA.

422-Control coal dust with ease

How to control coal dust in your coal handling operations is described in Bulletin 551-D. Discusses use of local exhaust ventilation and cloth-tube-type dust collector. Lists applications such as conveying, crushing, weighing, and batching of coal for use in power plant furnaces and boilers. Lists case histories and gives diagrams of well-designed materials handling systems. Four pages. WHEELABRATOR CORPORATION.

423-Power ladder eases maintenance

Hydraulic-operated ladder that rotates full 360 degrees, elevates to 75-degree angle, and reaches to 40-foot height, is described in this bulletin. Describes hydraulic circuits, ladder construction, and automatic throttle control. Features safe, rigid ladder with dead-man controls that prevent movement when operator removes hand from control lever. Four pages. J. H. HOLAN CORPORATION.

424-Rubber-lined centrifugal pumps

Rubber-lined centrifugal pumps for handling corrosive and abrasive materials are discussed in Bulletin 301-1055. Eight performance curves are included showing capacity in gpm at three pump speeds for each model. Complete installation dimensions are included for each model. Describes additional equipment, including heat exchangers, demineralizers, and many types of pressure filters. Eight pages. INDUSTRIAL FILTER AND PUMP MFG. CO.

425-Industrial lighting specs

Standard specifications for industrial lighting units listing important specification changes and including up-to-date revisions are contained in Bulletin 31-F-233. Includes data charts showing coefficient of utilization and candle power distribution with various combinations of lights and reflectors. Lists standard specifications for 10 combinations of lighting units. Thirty-six pages. RLM STANDARDS INSTITUTE.

426-Heat-resistant cable manual

Data on heat-resistant cables including test results for Keystone butyl rubber insulation are included in Bulletin H-463. Includes performance data under conditions of high heat and extreme moisture. Tables, formulas, graphs and engineering data are included covering all phases of selecting and applying electric conductor cable. A recommended addition to the library of all power services engineers. Forty-eight pages. "KEYSTONE" HAZARD DIVISION, THE OKONITE COMPANY.

427—Rubber hose, belting manual

Need a ready-reference on rubber hose, belting, and packing? Catalog is fully illustrated, contains a wealth of information on sizes, weights, applications, and construction features for all users of industrial or mechanical rubber goods. Lists data on rubber hose from ¼ to 15 inch id. Contains belting data for materials handling applications in all sizes to meet your needs. An excellent bulletin for the library of all engineers. Seventy-two pages. HAMILTON RUBBER MANUFACTURING COMPANY.

428-Burning gas in your plant?

Gas burners for forced, induced, or natural-draft operation in power plants are described in Bulletin G-200-B. Completely packaged fully automatic heating systems in capacities from 400,000 to 25 million Btu input are included. Burners give efficient fuel burning and maximum adjustment to fit a wide variety of job requirements. Discusses features such as automatic safety pilot and three-way electronic flame failure protection system. Four pages. THE METTLER CO., INC.

429-Hand pump mounts in pipeline

New piston-type, positive-displacement, self-priming hand pump that may be installed in a pipeline is described in Bulletin 3011. Pump is available as barrel pump, pedestal pump, or with hose and nozzle delivery for maximum flexibility in handling industrial liquids. Double-acting pump may be revised to permit pumping in either direction. Four pages. BOWSER, INC.

430-Valve comparison data

Replacing or reordering valves? This bulletin contains current data on all well-known valves manufactured today. Comparisons are given for each valve in relation to a corresponding OIC valve. Covers valves in pressure ranges from 125 to 2500 psi in all configurations—gate, angle, globe, and check, and in all materials—steel, bronze, and iron. Twenty-two pages. THE OHIO INJECTOR CO.

431-Protective coating is rubber

Synthetic rubber coating for use in corrosive atmospheres and in general plant maintenance is described in Bulletin 701. Lists uses, ease-of-application, abrasion resistance, and weathering properties of Neoprene W. Also includes data on chemical resistance and economic discussion of coating selection based on "cost per sq ft per yr of service." Four pages. CARBOLINE COMPANY.

FREE COPIES

For free copies of these handbooks, bulletins and catalogs just circle the key numbers on the READ-N-CIRCLE card on page 69.

432-High velocity air conditioning

Read how advanced design, described in Bulletin DS-348-C, results in high-velocity air conditioning systems. Capacity ratings for fans range from 5 through 11½ inch static pressure in ½ inch increments. Includes complete accessories such as dampers, inlet vanes, and access doors. Lists special fans made in spark-resistant construction and for high-temperature applications. THE TRANE COMPANY.

433-Boiler cleaning case histories

Read how 25 power plant operators obtained excellent results in removing scale and rust in their water systems. Kwik-Kleen is noncorrosive—does not attack metals, valves, gaskets, packings, or paint. Permits complete, rapid removal of scale and rust—does not create undesirable odors or toxic fumes. Case histories give details of how savings up to 67 percent have been realized. Twelve pages. NORTH AMERICAN MOGUL PRODUCTS COMPANY.

434-Fittings without welds, threads

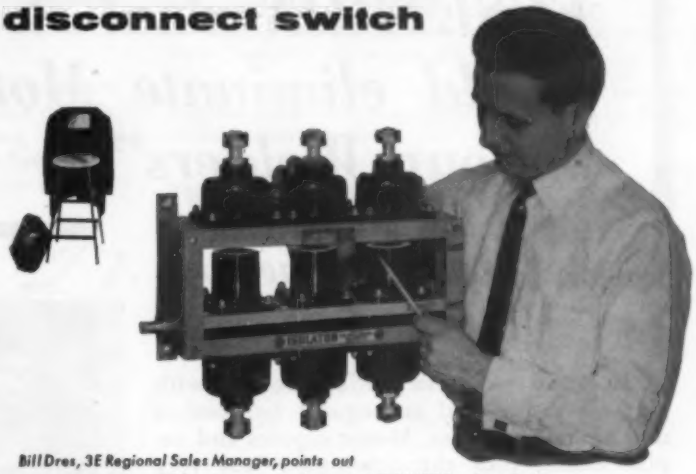
Structural fittings that can be assembled without welding or threaded connections are described in this bulletin. Fittings may be used with any pipe to build storage racks, railings, maintenance stands, and similar structures. Describes how pipe is held by a lock screw in the fitting. Contains data on complete line of fittings. Ten pages. NATIONAL INDUSTRIAL SUPPLIES CO.

435-Silicone rubber seals better

Silicone rubber sealing material that withstands high and low temperatures, resists sunlight and ozone, possesses excellent dielectric properties, and resists mineral-oil swell at high temperatures is discussed in Bulletin AD 147. Contains lists of silicone rubber styles and application recommendations for the complete line. Available in extruded, molded, die-

(more new bulletins on page 28)

Straight line action makes ISOLATOR the most efficient disconnect switch



Bill Dres, 3E Regional Sales Manager, points out the visible air gap—an important ISOLATOR safety feature

ISOLATORS save on cubicle construction and floor space because they take about ½ the space required by equally rated knife switches. They also weigh less and as all elements, including poles, are mounted and aligned on a rigid frame at 3E, they are simple to install. When the ISOLATOR moves from closed to open position its current carrying parts move in a straight line and telescope as contact is made. The parts are enclosed in insulated bushings which also telescope, shielding live parts and eliminating flash barriers.

ISOLATORS are safer . . . in the open position, the gap between the bushings is easily visible. Yet the opening is narrow enough to lessen the chance of accidental contact with the live parts. The exposed studs at top and bottom are arranged for easy taping. When your men work in cubicles equipped with ISOLATORS they will be safe from live part hazards.

This switching center, designed and built entirely by 3E, shows how ISOLATORS make a compact, functional and handsome unit. These are 5 KV, 200 ampere ISOLATORS. The ISOLATOR is also ideal in combination with potheads; any number of arrangements are possible and the units are easily interchanged if necessary. 3E makes many kinds of indoor and outdoor switches, and has a staff of engineers experienced in designing complete units for all types of special applications.

On your next switching problem, See 3E for recommendations and estimates.

For ISOLATOR data ask for Bulletin 140

ELECTRICAL ENGINEERS EQUIPMENT CO. Melrose Park, Illinois

Circle 114 on READ-N-CIRCLE card for more data

"We found by actual tests that FUSETRON dual-element FUSES would eliminate Motor Burnouts on our Welders"

"Here are the facts . .

"In 1946 we were having trouble with single phasing and subsequent burnout of our 3-phase welders. Motor repairs and replacements, plus the down-time was very costly.

"Could this situation be corrected, we wondered, by individually protecting each welder with Fusetron fuses?

"We ran our own test to find out. On 400 ampere welders — 3 pole fuse blocks were mounted in a steel enclosure. 80 ampere, 250 volt Fusetron fuses were installed on the load side of the enclosure.

"The circuits were then single phased. On every test the Fusetron fuses opened in 21 to 23 seconds.

"On checking further with a hook ammeter we found the locked rotor current to be 325 amperes.

"As a result of these tests, we protected all 62 welding machines with Fusetron fuses in the proper motor protection sizes.

"Sure, since then we have blown a number of fuses — but we have not had one motor burnout due to single phasing. Fusetron fuses have certainly cut costs for us.

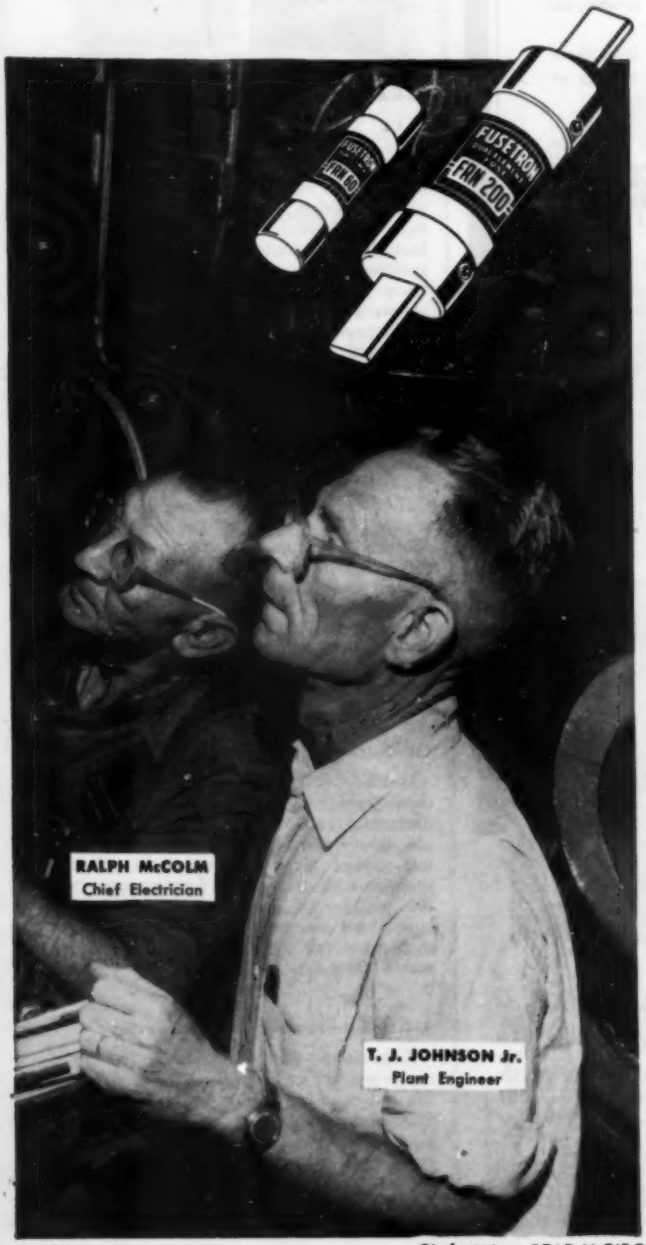
"Today, there are 147 welding machines in operation and each is protected with Fusetron fuses."

Ralph McColm
CHIEF ELECTRICIAN
BLACK SIVALLS AND BRYSON, INC.
OKLAHOMA CITY, OKLA.

why Fusetron Fuses can protect motors against burnout

Fusetron fuses have a tremendous time-lag. This means, on normal installations, Fusetron fuses can be used in motor-running protection sizes — without opening on motor-starting current or other harmless overloads.

When so used, Fusetron fuses protect motors from any harmful excess of current caused by such things as single phasing, overloading, wrong voltage, being stalled, lack of oil, tight belt, worn bearings or anything that causes the motor to draw a dangerously excessive current.



Fusetron Fuses provide simplest way to prevent damage from single phasing

When single phasing occurs, the current in the remaining phase increases about 100%. (Theoretically 73%, but change in efficiency and power factor makes it about 100%).

This 100% overload on Fusetron fuses of motor-running protection size opens them and stops flow of current to the motor.

FUSETRON FUSES DO MORE THAN PROTECT MOTORS AGAINST BURNOUT

They provide 10 Point Protection

1. High interrupting capacity — protect against heaviest short-circuits. Have proven on tests to open safely on circuits set to deliver in excess of 100,000 amperes.
2. Protect against needless blows caused by excessive heating — lesser resistance results in cooler operation.
3. Protect against needless blows caused by harmless overloads.
4. Provide thermal protection — for panels and switches against damage from heating due to poor contact.
5. Protect against waste of space and money — permit use of proper size switches and panels.
6. Protect motors against burnout from overloads.
7. Give DOUBLE burnout protection to large motors — without extra cost.
8. Protect motors against burnout due to single phasing.
9. Make protection of small motors simple and inexpensive.
10. Protect coils, transformers and solenoids against burnout.

More information on Fusetron dual-element fuses is available. Write for bulletin FIS.

FOR LOADS ABOVE 600 AND UP TO 5000 AMPS. — USE BUSS Hi-Cap FUSES!

On 600 volts or less, they have interrupting capacity sufficient to handle any fault current regardless of system growth.

They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outages to circuit of origin.

Write for bulletin HCS.

Play Safe! *Install FUSETRON dual-element Fuses and BUSS Hi-Cap Fuses throughout entire Electrical System!*

BUSSMANN MFG. CO. FUSETRON BUSS Div. of McGraw Electric Co.

University at Jefferson, St. Louis 7, Mo.

Circle 116 on READ-N-CIRCLE card for more data

NON-FLUID OIL

TRADE MARK REGISTERED

STARTS LUBRICATING SOONER AND LASTS LONGER IN PRESSURE SYSTEMS

Unlike common greases, NON-FLUID OIL does not require heat softening in order to start lubricating . . . your pressure-lubricated machinery runs smoothly *continuously* and with no heating or wear of bearings, and no "down time" for repairs due to inadequate lubrication.

And what is even more important, NON-FLUID OIL lasts three times as long as ordinary lubricants . . . with obvious savings to the user in time, money and materials.

Send for your free testing sample today.

NEW YORK & NEW JERSEY LUBRICANT COMPANY

292 MADISON AVE., NEW YORK 17, N. Y.
WORKS: NEWARK, N. J.
WAREHOUSES

Birmingham, Ala. Columbus, Ga. St. Louis, Mo.
Atlanta, Ga. Springfield, Mass. Providence, R. I.
Charlotte, N. C. Detroit, Mich. Chicago, Ill.
Greenville, S. C. Greensboro, N. C.

NON-FLUID OIL is not the name of a general class of lubricants, but is a specific product of our manufacture.

Circle 124 on READ-N-CIRCLE card for more data

A FULL TIME TRAFFIC COP
on your fluid hiway

HENSZEY
FLOW METERS
with Alarm Control

RINGS A BELL—LIGHTS A LIGHT or ACTIVATES a MOTORIZED VALVE

There are only three moving parts in the HENSZEY FLOW METER — no breakdown due to complicated gears and mechanism. Goes right in the line — no additional supports. Indicates flow within 3% absolute accuracy, even with pulsating flow. Send for bulletin.

SOUND ALARM AT HIGH OR LOW FLOW!

Easy to set on face of switch — unaffected by dust, dirt or corrosion — no pitting or sticking.

HENSZEY COMPANY
DEPT. A5, WATERTOWN, WISCONSIN

Circle 120 on READ-N-CIRCLE card for more data

new bulletins

. . . starts on page 22

cut, and metal-bonded. Eight pages. GARLOCK PACKING COMPANY.

436-Airfoil fans improve draft

Air foil fans with wheel diameters from 30 to 98 inches in each of six different designs are discussed in this bulletin. Wide range of equipment makes close selection of size possible to give highest efficiency for every requirement. Includes formulas giving fan laws, specific speeds, and complete calculations involving fan selection. Separate charts give capacities of each fan type. Eight pages. THE GREEN FUEL ECONOMIZER COMPANY, INC.

437-Save with engineered insulation

Complete engineering data on installation to control temperatures from −400 F to +3000 F are contained in Bulletin IN-171A. Includes data card giving the complete insulation line, showing recommended temperatures for handy reference. Gives a wealth of typical installations showing construction methods with results obtained. Lists recommendations for refrigeration sheets, air conditioning ducts, pipe insulation, cement, and fills. Twenty pages. JOHNS-MANVILLE.

438-Quick-opening heat exchangers

Quick-opening locks with both pneumatic and manual control for use on horizontal and vertical heat exchangers are described in Bulletin 2030. Self-sealing gasket gives pressure-tight joints through a pressure range from vacuum to 300 psi. Lever-Lock equalizes load of supporting members and allows opening in five seconds. Four pages. THE PATTERSON-KELLEY CO., INC.

439-How to remove airborne wastes

Exhausters designed specifically for removing smoke, dust, and for conveying and handling hot air and gases in industrial processes are described in Bulletin SPE-103. Lists three special wheel types for maximum efficiency and length of service. Exhausters are available with direct or V-belt drive. CHICAGO BLOWER CORPORATION.

440-How are pressure vessels made?

Specialized manufacturing facilities for fabrication of pressure vessels, high-pressure piping, and unusual weldments are described in Bulletin GS-56-4. Describes equipment such as: an 8000-ton hydraulic beam press for plate forming and bending, a 50-ton crimping press for one-piece cylinder rolling, submerged arc automatic welding machines, and a 2-million volt Van de Graff X-ray generator. Eighteen pages. FOSTER WHEELER CORPORATION.

441-Annunciator system polices self

Annunciator system polices self discusses in nontechnical language the "what," "why," "where," and "how" of annunciator alarms. Advantages of annunciator alarm systems listed for monitoring any process. Lists installation dimensions for individual units as well as group panelboard mountings. Includes prices of annunciators alarm accessories. THE SCAM INSTRUMENT CORPORATION.

442-Technical water treating data

Operating factors and selection of chemical treatment for water clarification are discussed in Technical Reprint T-138. Discusses theoretical chemical problems of coagulation and physical consideration of the process. Describes tests to determine the proper chemical to use (that can be made in either field or laboratory). Describes chemical test kit, method of planning tests, and typical report form. Ten pages. GRAVER WATER CONDITIONING COMPANY.

FREE COPIES

For free copies of these handbooks, bulletins and catalogs just circle the key numbers on the READ-N-CIRCLE card on page 69.

443-Insulation can be applied cold

Cold-applied asphaltic compounds provide durable protective coating for all insulation applications in refineries, chemical plants, and power stations. Can be applied as weather coating over magnesia insulation, cork block, concrete, or compacted earth fill. Bulletin lists application recommendations and physical properties. Eight pages. AMERICAN BITUMULS & ASPHALT CO.

444-Electric heater data

Application recommendations, engineering data, operating information, and list prices for electric heaters and heating devices are contained in Bulletin GEC-1005G. Includes immersion, strip, cartridge, tubular, and fin heaters. Also discusses unit heaters, oven equipment, and controls. Contains information on all types of electric heater and heating devices. Sixty pages. GENERAL ELECTRIC COMPANY.

445-Read about molybdenum silicides

Get information on molybdenum silicides including preparation, application, and chemical, physical, and mechanical properties of these refractory compounds. Bulletins Cdb-6 and CH-23, list characteristics—unaffected by most inorganic acids including aqua regia, resist oxidation up to 1700 C, and have superior strength at elevated temperature in comparison to some unalloyed metals. Ten pages, two bulletins. CLIMAX MOLYBDENUM COMPANY.

446-Welder gives emergency power

Handy, compact, self-contained welding unit that provides up to 4 kva standby electric power, yet weighs only 550 pounds, is discussed in this bulletin. Includes drawings for both self-contained unit with gasoline engine and belt-driven generator unit. Flexible unit provides current from 20 to 200 amperes and can be used for welding, hard surfacing, brazing, and soldering. Four pages. THE LINCOLN ELECTRIC COMPANY.

PROOF POSITIVE

foster MASTIC COATING RESISTS FIRE

Arc welding above freshly-applied Foster 60-60N (left) fails to ignite coating; while ordinary asphalt mastic (right) ignites and burns fiercely until consumed.

foster Fire-Resistive Mastic 60-60N is:

Non-flammable during (and after) application by spray or trowel—no danger of ignition from welding sparks or splatter.

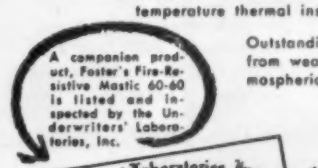
Fire-resistive when dry, won't add fuel to accidental fire exposure. (Foster 60-60 is still the only weather-coating listed by Underwriters' Laboratories).*

An effective barrier to moisture vapor; a requirement for coating low temperature thermal insulations, (vapor permeance 0.02 perm).

Outstanding for protecting steel and thermal insulation from weather and chemicals (both liquid spillage and atmospheric fumes);

Unparalleled by any conventional mastic coating for retained flexibility under prolonged heat and sunlight.

A companion product, Foster's Fire-Resistive Mastic 60-60 is listed and inspected by the Underwriters' Laboratories, Inc.



*Dry film of 60-60N is identical with dry film of 60-60. 60-60N is an improved mastic made with non-flammable, non-toxic volatile solvent.

BENJAMIN foster COMPANY
4635-37 W. Girard Avenue
PHILADELPHIA 31, PA.
Distribution and Technical Services available in principal U. S. and Canadian Industrial Areas.

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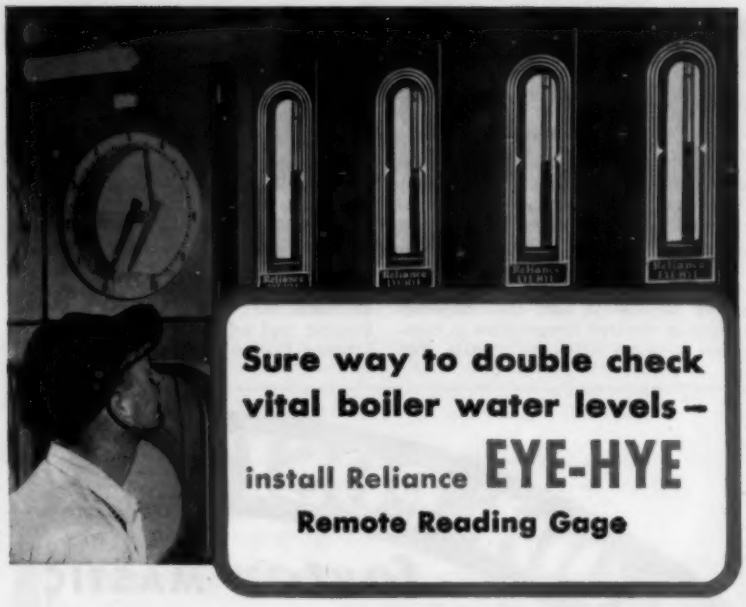


Sure way to double check vital boiler water levels –

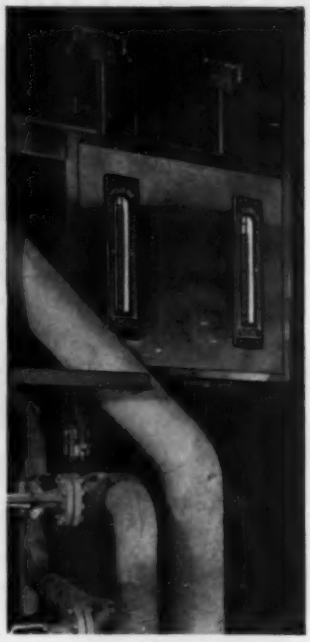
install Reliance EYE-HYE

Remote Reading Gage

It's fine to have automatic controls, but be sure you have the important safeguards against possible failure — adequate *maintenance* and *cross-checks.*

EYE-HYE is your reliable cross-check for *boiler water levels.* A manometric-type remote reading gage, it keeps operators informed on water level status. Easier to read than conventional gages, although it's the same familiar form — a vertical column of liquid. EYE-HYE's indicating fluid is a pleasing green that "pops out", brightly illuminated from the rear.

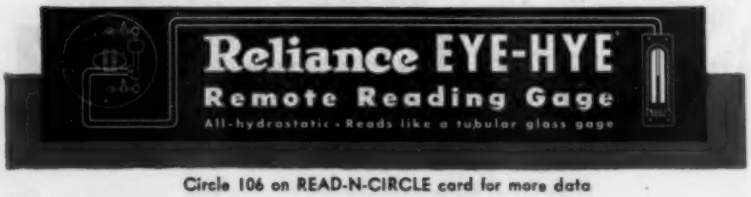
You can place EYE-HYE any reasonable distance from the drum — above or below it, on wall or instrument panel. Easy to install and maintain — no mechanical working parts — no adjustments on location. Write for Bulletin CO and learn how EYE-HYE can increase the efficiency of *all* your water levels.



How one user checks water levels in surge tank and feed water heater with long type EYE-HYEs. (Face plate can be calibrated at factory.)

The Reliance Gauge Column Company

5902 Carnegie Avenue • Cleveland 3, Ohio



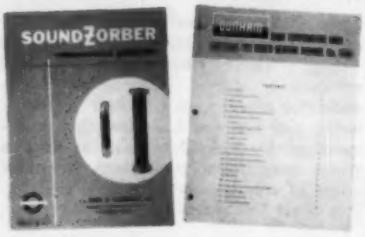
Circle 106 on READ-N-CIRCLE card for more data

new bulletins

. . . starts on page 22

450-Read about flyash collectors

New, package flyash collector and induced draft unit is described in this Bulletin. Explains installation, operation, and advantages obtained with this unit. Lists charts and sections showing operating principles. Six pages. BRESLOVE SEPARATOR COMPANY.



447-Wire-reinforced rubber pipe

Wire-reinforced rubber pipe that eliminates noise and vibration from waterlines is described in Catalog SZ-55. Gives operating characteristics and temperature ranges to 180 F for liquids, brine, and hot water lines, at operating pressures to 250 psi. Includes typical installations with dimensions for noise, vibration, and water hammer control. Four pages. T. R. FINN & COMPANY, INC.

448-High-temperature water manual

All phases of high-temperature, high-pressure hot water heating systems are covered in Manual 2685. Text and illustrations cover hot water heating from system thermodynamics to corrosion minimization. Includes five tables, five charts, and seventeen schematic diagrams giving engineering data to simplify selection of system components, boiler feed pumps, valves and pipe fittings, pump locations and pipe sizes. Twenty-eight pages. C. A. DUNHAM COMPANY.

FREE COPIES

For free copies of these handbooks, bulletins and catalogs just circle the key numbers on the READ-N-CIRCLE card on page 69.

449-Cable troughs are flexible

Cable troughs engineered for easy installation are described in this bulletin. Contains installation instructions, load charts, accessory items, typical installations, and list of distributors. Discusses how simple solutions to problems of change of direction or elevation can be solved with a complete set of standard fittings, horizontal elbows, inside and outside vertical elbows, ties, and crosses. Twelve pages. THE GLOBE COMPANY.

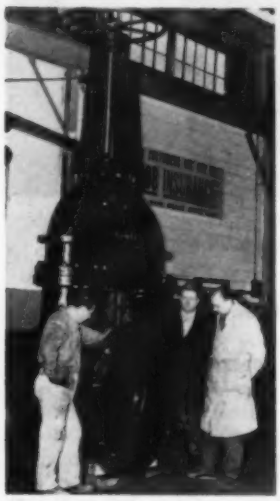
(more bulletins on page 73)

ideas in action

. . . for industry & power

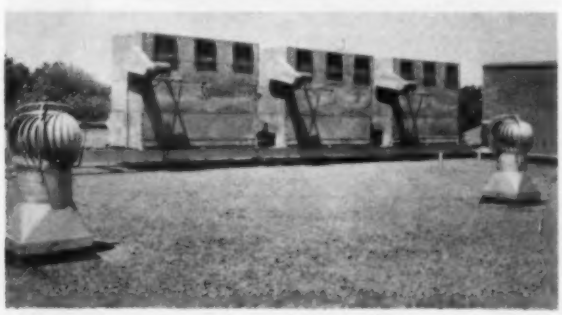
No old age pension for these valves

Complete reconditioning of all types and sizes of valves saves many years of useful life. This 40-inch steel gate valve, measuring 15½ ft in height and weighing 7 tons, was recently put into like-new condition by the Universal Machine & Valve Mfg. Company. Universal specializes in valve repair work, and, since 1949, has reconditioned more than 600,000 worn out valves. Reconditioning consists of complete disassembly, cleaning and inspection of all parts, replacement and manufacture, if necessary, of replacement parts, and reassembly. Valves reconditioned by the company include valves constructed of any material and for any working pressure.



Roof-mounted cooling towers stretch brewery's water supply

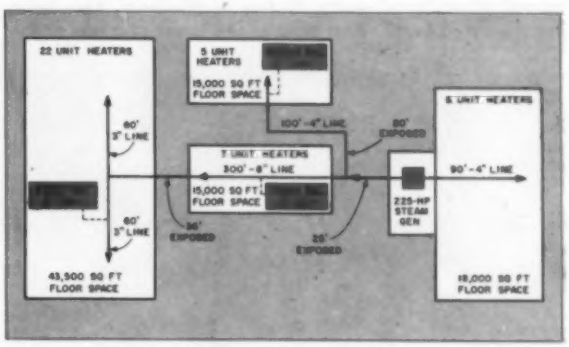
Roof-mounted cooling towers are saving the Frankenmuth Brewing Company over $2000 a year in water costs. Large quantities of water are needed in the brewery to cool canned and bottled beer after it is pasteurized from 140 to 70 F. This continuous process formerly required 15 gallons of water per barrel of beer. Since installing cooling towers, this quantity has been reduced to 10 gallons per barrel — a saving of one-third. Each of three free-



flowing towers has a 60-ton nominal capacity, and circulates 180 gallons of water per minute — total of 540 gpm being handled by a single pump. Loop arrangement permits towers to drain when pump is shut off, thus eliminating danger of freezing in cold weather. Cooling towers not only are saving money but have eliminated the necessity for an expensive addition to the brewery's water system which had reached its present capacity.

No idle Btu's in this boiler

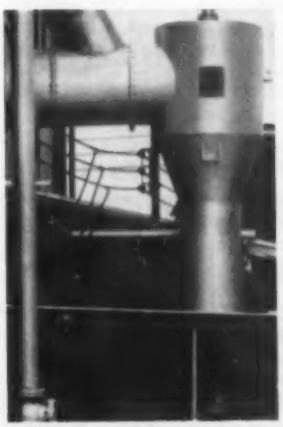
One 225-hp, 15-psi steam generator carries the entire heating load for four buildings (91,500 sq ft floor space) at Arvin Industries, Inc., North Vernon, Ind. Boiler also serves cleaning and electroplating tank requirements. Only during extremely cold weather is the standby boiler



used. Forty unit heaters, and 27 tanks containing 34,000 gallons of water, are served by this steam generator. Water temperature in the tanks is maintained at temperatures from 120 to 212 F by circulating steam through pipe coils. York-Shipley package steam generator, burning low-cost No. 6 fuel oil was installed in 1952 to retire outmoded coal-fired equipment. Steam from the same 225-hp generator is used to distill water for mirror-silvering operations.

Scrubbers eliminate intolerable fume problems

Ammonia fumes, emitted during manufacturing processes, made working conditions in a section of a soap plant unbearable. Installation of 36-inch Schutte and Koerting fume scrubbers cooled the inlet air and removed objectionable fumes. Fume-laden air at 110 F is passed through the scrubber and then through a water spray box. Air is cooled to within a few degrees of the spray water temperature. Air is then recirculated through heaters to increase its temperature to 70 F, and to reduce humidity to 70 percent. Clean air is then returned to the building. Thus, fume removal and air conditioning are achieved by scrubber and water spray with the only cost being that of power required to pump the cooling water.



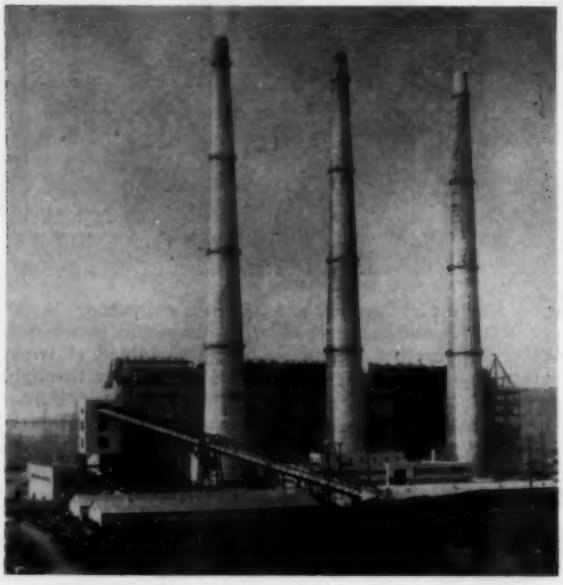
(more ideas in action on page 32)

ideas in action

. . . starts on page 31

Chimneys shelter vital equipment

Three 600-foot chimneys at Ohio Valley Electric Corporation's plant in Cheshire, Ohio reflect the latest design concepts learned from atomic bomb tests. Built of reinforced concrete by the M. W. Kellogg Company, the $2 million structures have foundations that are 76 feet square and 10 feet deep, resting on filled ground consisting of layers of sand and gravel. As a precaution and safeguard, seven large rooms, 50 feet in diameter, have been incorporated for the first time in the lower sections of the



chimneys themselves. These rooms house emergency equipment, controls, switchboards, a 250,000-gallon water tank, and areas for miscellaneous storage.

Stainless steel has been used in the four balconies on each chimney, and on the cone-shaped caps, which were specially designed to disperse noxious gases. Gas velocity in the chimneys is the highest ever designed. Gases from the boiler leave the chimneys at a velocity of 120 ft/sec. Other innovations include enclosed outside ladders.

Metallizing makes money for shipyard

One of the most revolutionary time and money savers ever adopted by Alabama Drydock and Shipbuilding Company, Mobile, Ala., has been the metallizing process. Before using the metallizing process, many parts were scrapped and new ones made or purchased. Often electric or acetylene welding was used. Choice of metals was limited, and shrink or warping often tended to weaken the parts. Main attraction of metal spraying is that build-up is done with almost cold metal. Sprayed coatings seldom exceed 350 F, which is insufficient to effect the base material. Production time on some jobs has been reduced as much as 40 percent. Work done with the equipment has ranged from ¼-inch fan motor shafts to stern tube bushings with 36-inch diameters. Although other methods

could be used sometimes, cost usually would be prohibitive and quality of the finished job questionable.

Storage tanks profit from radiant heat

Hot water coils, placed under 24 steel storage tanks at the Port of Seattle's new $300,000 tank farm, heat non-petroleum oils to pumping temperature. Usually, coils are placed inside tanks. New system frees inside of tanks from obstructions, and permits quicker and easier cleaning. To prevent heat loss from the coils through concrete foundations, Foamglas cellular glass blocks were laid on top of the foundations. This insulation has sufficient compressive strength (7 tons/sq ft) to withstand the

weight of the tanks and their contents. Cellular glass insulation is impervious to moisture infiltration, will provide a constant insulating value, and will eliminate the difficult problem of replacement through deterioration.

Glass blocks were applied over concrete slab foundation using hot asphalt as adhesive. Roofing felts were mopped in place over the blocks. Hot water coils were then installed and covered with a concrete grout, and tanks positioned.

(more ideas in action on page 63)

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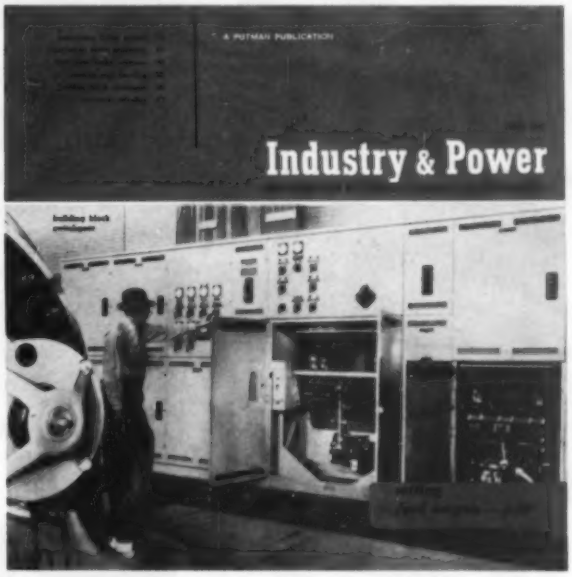
this month's comment . . . .

another step forward . . . .

Next month, INDUSTRY & POWER takes another great step forward by introducing its new format—big in size, square in shape.

INDUSTRY & POWER will be the same height as now—and it will be as wide as it is high. Bigger pictures and graphs; more-readable articles.

We are certain that *you* will find this format as helpful and interesting as we do. Why? Simply because big, square-size format offers a freedom unmatched by ordinary format. This freedom permits printing working charts in sizes practical for you to use, with accuracy maintained within the stretch-and-shrink limits of the paper itself. Photographs will be so large and clear that you will see every important detail—detail beyond the power of words to describe.



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Harold A. Bergen

Editor

"Mogul Kwik-Kleen does amazing job, removing 96% scale from sweet water cooler." Minnesota

"Mogul Kwik-Kleen solves vexing scale problem in 2 - 1000 ton refrigeration condensers and 2 - 1000 ton surface condensers." Texas

"Remarkable cleaning job in induced draft cooling tower, serving 4 air conditioning systems — 50% saving in time, 50% saving in cost." Tennessee

"99.9% scale removed from absorption type water chiller in air conditioning system." Alabama

"Wood flour and scale successfully removed with Mogul Kwik-Kleen from 100 ton evaporative condenser." Indiana

"Special high temperature generator cleaned by Mogul Kwik-Kleen with results beyond all expectations." New Jersey

"Large air compressor descaled in 7 hours. Former manual cleaning required 2 men 4 days." Connecticut

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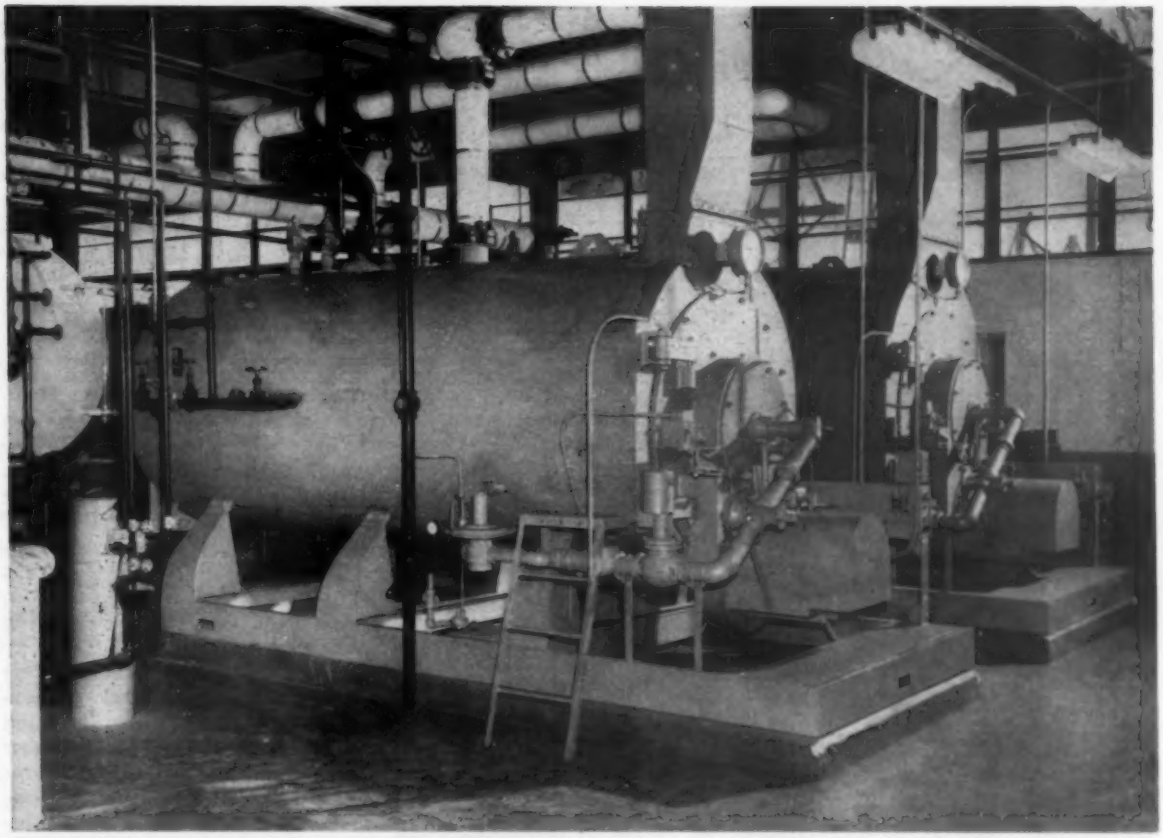


Two Cyclotherm package boilers, operating at 90 psi, take care of varying winter load by selective use of capacities.

Investigate every angle before

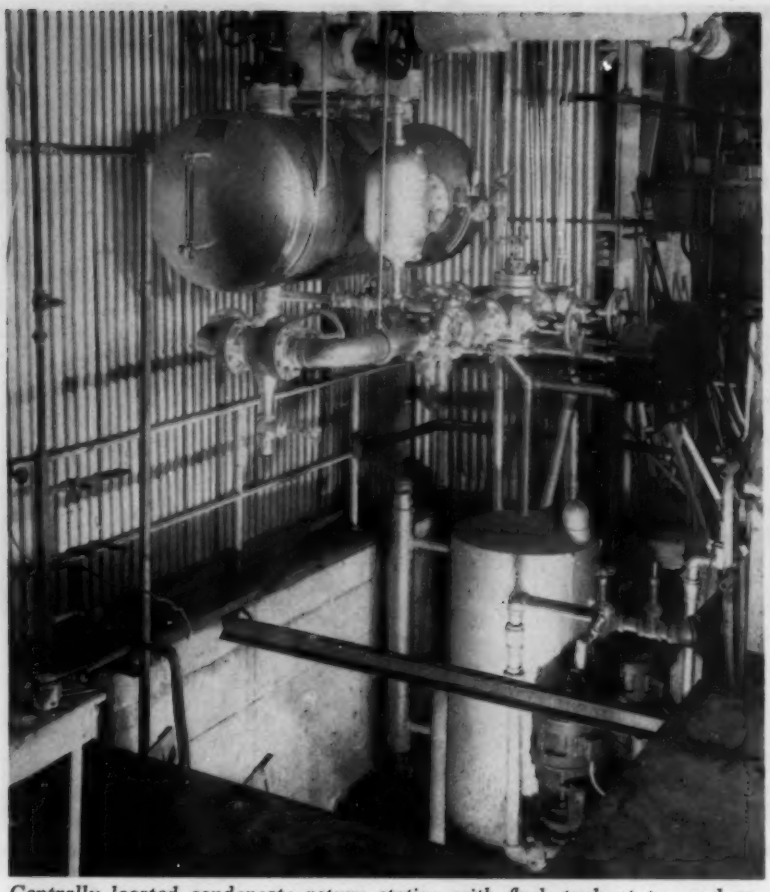
You buy *ANOTHER BOILER*

DONALD HARTLEY
Associate Editor

WHERE CAN YOU cut down on the boiler horsepower recommended for a proposed installation? That was the question that faced engineers at ZCMI Wholesale Distributors, Salt Lake City, two years ago when they decided to change over their steam operations. According to the local gas company engineers, brought in to estimate the steam load and make recommendations, ZCMI required approximately 600 horsepower. But J. C. Rich, operation superintendent, and Al Harris, maintenance supervisor, felt that the job could be done with less capacity. It was only a hunch, however, and more conclusive proof was needed.

ZCMI's plant was originally built as a government project. A separate powerhouse was erected at the time the buildings were constructed. Steam was bought at rates established by the Public Service Commission from this central powerhouse which, although owned by the company, supplied steam to other plants as well. It was decided to eliminate the central powerhouse which is now leased to another company. Existing overhead steam line from central powerhouse to warehouse was also eliminated.

Steam meter readings were analyzed very closely but it was felt that they were not too reliable. Cadillac condensate meter readings were then analyzed and it was discovered that 150 horsepower would carry the entire heating load from the beginning of the season to about December 1. After that, 250 horsepower would be needed to carry



Centrally located condensate return station with flash tank at top and receiver in pit. Two condensate pumps in pit are used alternately every month.

MONTHLY STEAM COSTS

	Average Monthly Temperature (F)	Degree Days	Steam Cost ($)	Gas used (Cu Ft)
1953-54 (using old boilers)				
OCT.	56.1	288	1368.66	
NOV.	47.8	509	2969.81	
DEC.	29.9	1086	3696.06	
JAN.	34.6	951	3884.99	
FEB.	37.4	768	3810.02	
MAR.	38.5	813	3494.22	
APR.	55.1	293	1211.73	
MAY	63.2	136	157.24	
TOTAL		4844	20,592.73	
1954-55 (with increased load)				
OCT.	52.3	399	1012.00	4,561,000
NOV.	44	622	1914.81	6,565,000
DEC.	30.3	1070	2719.11	7,368,000
JAN.	21.1	1353	2968.57	6,028,000
FEB.	24	1142	2520.30	4,222,000
MAR.	37	871	1801.28	2,522,000
APR.	45.7	572	1166.25	850,000
MAY	56.8	257	540.60	191,000
JUNE	66.3	85	278.85	
TOTAL		6371	14,921.77	32,307,000

the entire load as long as the temperature remained above freezing. Once the temperature went below freezing, more than this 250 horsepower would be needed to keep a half-million gallon water tank from freezing and still maintain the heating load. A logical solution seemed to be to install two boilers, one with 150-hp and one with 250-hp capacity, rather than one 400-hp boiler.

HRT boilers are usual

Most operators in the Salt Lake City area use HRT boilers. However, if an HRT boiler large enough to handle the maximum load were installed, boiler efficiency would be lost during the early months of the heating season. If a smaller HRT boiler were used, counting on its overload factor to see the plant through the coldest winter months, efficiency must be sacrificed during the worst months.

Space was another consideration. Abandoning the central powerhouse necessitated either building another powerhouse for the new boilers, or using some spare warehouse space. It was decided to install two Cyclotherm fully modulating 90-psi package boilers in a corner of the warehouse. Boilers, factory tested and ready to run, were shipped in, placed on concrete pads prepared in advance, and hooked into the gas, water, and heating mains. No time was wasted on installation.

Half-million gallon water tank was moved and put on the line. Water tank temperatures must be maintained above freezing for the plant's fire protection system.

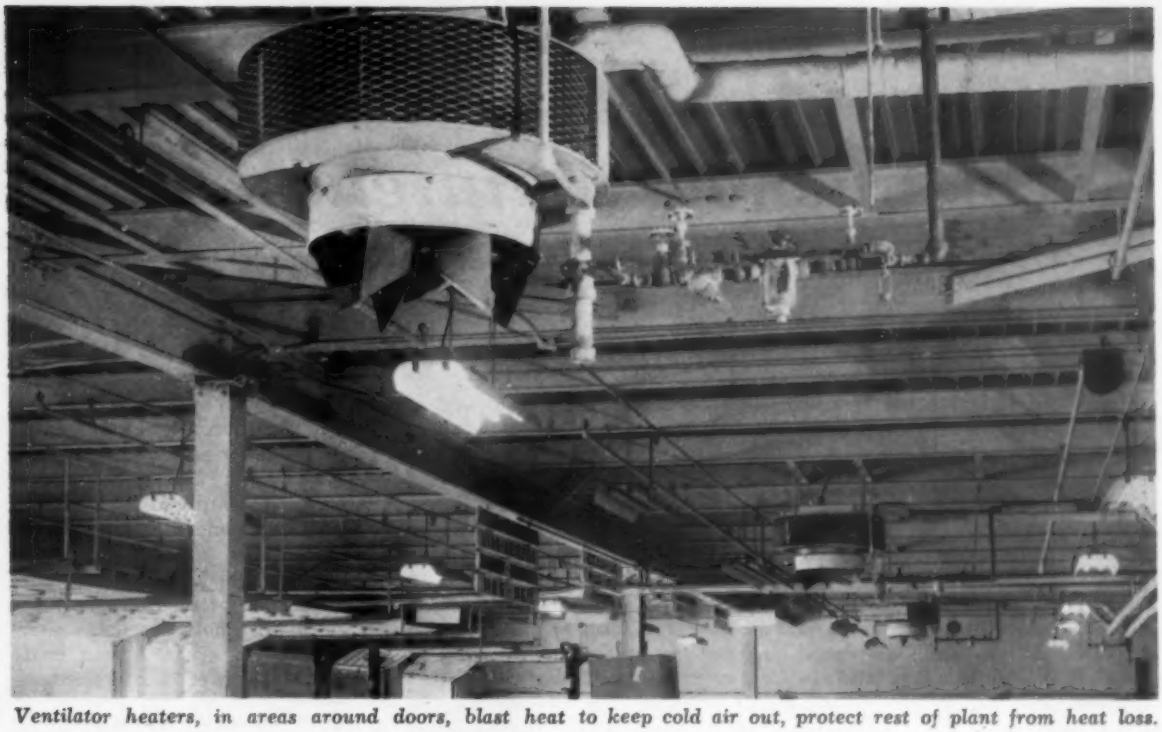
Installation cost of these two boilers was about $56,000, including moving the water tank and building a small pump house.

One big advantage gained was that of single responsibility for the entire installation. Installation was made by Palmer-Christiansen, Salt Lake City, under the supervision of Jerry Wright, a local consulting engineer.

Boilers use little space

Both boilers with their auxiliaries fit nicely into a corner of the steel warehouse, taking about one-half the space necessary for an HRT boiler.

Adequate working temperatures



Ventilator heaters, in areas around doors, blast heat to keep cold air out, protect rest of plant from heat loss.

are maintained in warehouse and office areas with much less steam capacity than first recommended. This is accomplished by heating only areas where people are working, with the exception of the shipping and receiving dock.

Leakage makes savings

Heat from the mezzanine (which covers about 1/3 the warehouse area) leaks off to keep that part of the warehouse warm that is not otherwise heated. It is by taking advantage of this "leakage" that temperatures can be maintained with the lower hp. Wherever doors must be open most of the time — such as the shipping and receiving docks — ventilating units are installed to blast heat at each opening, keeping the cold air out. In periods of fluctuating temperatures, No. 1 boiler (150 hp) automatically cuts out and No. 2 cuts in when steam demand exceeds the capacity of the smaller unit. Continuous steam pressure readings are obtained with a Trerice recorder at a station 1100 feet from the boilers. Longest steam line is approximately 1700 feet. Despite the large area to be heated, heat is available throughout the building within 40 minutes of starting up the boilers.

Condensate is gravity fed to a central point, then pumped back to the boiler condensate system. This return system is a remnant of the days when steam was purchased from the central powerhouse and condensate was returned to this outside building.

Auxiliaries are automatic

Water softeners, feed pumps, and condensate return pumps all operate automatically. System includes twin bypass water treatment tanks located at the rear of the 500-gallon condensate tank. Two condensate pumps are alternated every 30 days, with one on continual standby. A Fisher float valve controls flow to receiver. Pumps can feed either boiler. Makeup runs about 11 percent.

Careful daily records are kept on these boilers. They have delivered 83-percent efficiency since installation. Daily maintenance consists of a water check, blowdown, CO_2 check, efficiency reading, stack temperature, and gas pressure readings.

During the 1953-54 heating season, the steam bill was $20,592.73. This steam served to heat the building with 10½ acres of floor area under glass during a heating season that totaled 4844 degree days. During the first heating season after the new boilers were installed, (1954-55) heating costs dropped to $14,921.77. This includes all the extras added to the load and excludes the fact that the winter totaled 6371 degree-days (32 percent more severe than the preceding season). Thus, the heating bill has been reduced more than $5000 per year, despite heavy additions made on the load, and a more severe winter.

Look before you buy

Moral of this story is that new boilers should be bought only after thorough consideration has been given to every angle. It is foolish to specify boilers with such small capacity that freak conditions cannot be met with ease. On the other hand no one wants to buy unnecessary horsepower. It is quite conceivable that you can take advantage of some condition peculiar to your plant as ZCMI engineers did. Those not-so-obvious factors make the difference, so take a good look around you and investigate every angle before you specify your next boiler.

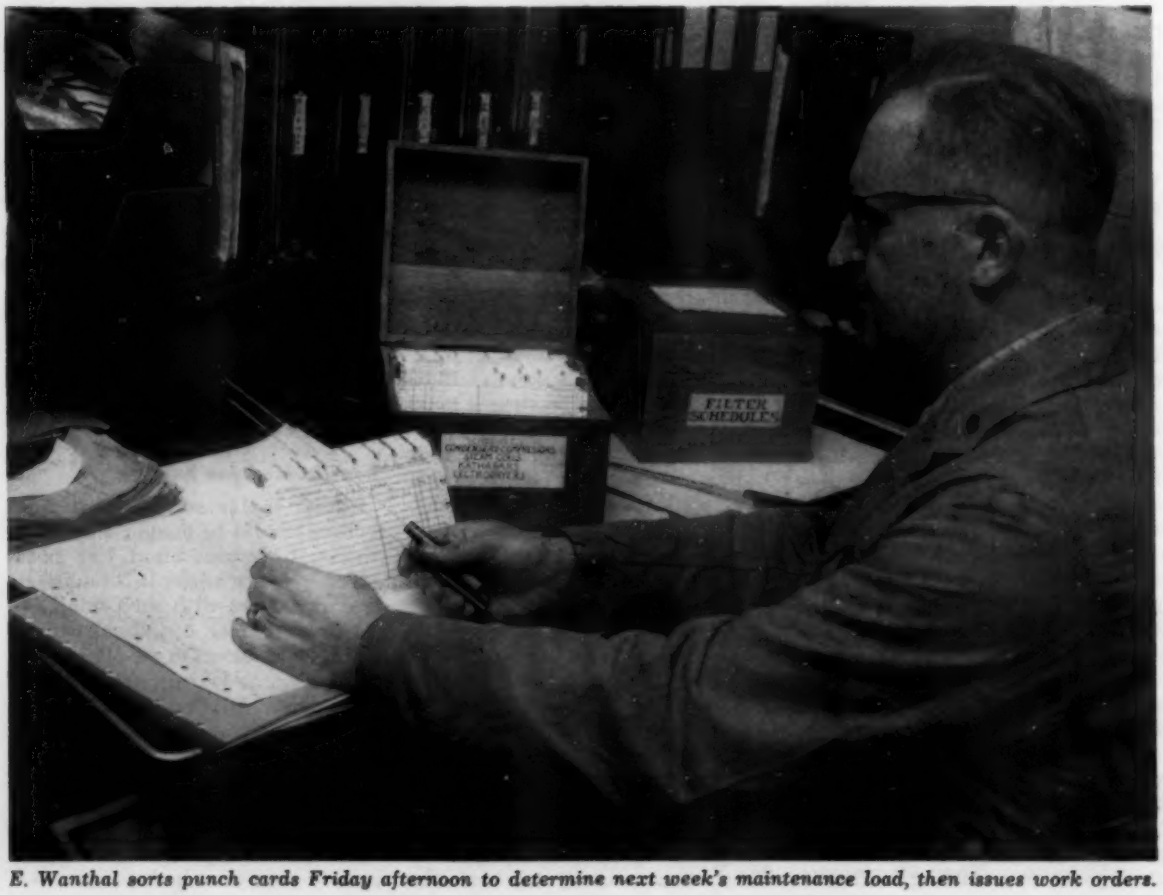
How Abbott *slashes* air conditioning *maintenance 25%*

A. E. BOHLAND,
Kathabar Division
Surface Combustion Corporation

AIR CONDITIONING maintenance labor can be reduced 25 percent by anticipating needs of equipment before repairs become necessary. Abbott Laboratories is proving it, using their air conditioning all year long. Air conditioning is vital to Abbott's production because of special operations that call for sterile air, close moisture and temperature control, and good working conditions. But simple forms, a punch-card system, and an established routine for using them keep exact control on all work done and scheduled to keep their air conditioning equipment working. They get less downtime and reduce maintenance labor 25 percent at the same time.

Air conditioning systems, no matter how well built or installed, are subject to unavoidable maintenance problems. Abbott engineers have developed an air conditioning maintenance program that anticipates whatever can be anticipated, mitigates what cannot be anticipated, and continually checks to keep all equipment in top operating condition.

Program delegates responsibilities along the production flow lines of the plant. There are three main manufacturing areas. A staff engineer is in charge of maintenance en-



E. Wanthal sorts punch cards Friday afternoon to determine next week's maintenance load, then issues work orders.

gineering on equipment in each area, and manager of area maintenance coordinates their work. Central shop supplies maintenance personnel and maintains equipment involved in heating, ventilating, air conditioning, refrigeration, instrumentation, and other plant power services.

Whole maintenance field has been broken into two general categories — preventive and scheduled maintenance. Preventive maintenance program automatically calls out work orders for inspection of components that must be watched most closely. These include lubrication systems, belts, refrigerants, and lithium chloride solutions used in humidity conditioners. Preventive maintenance is done at close intervals.

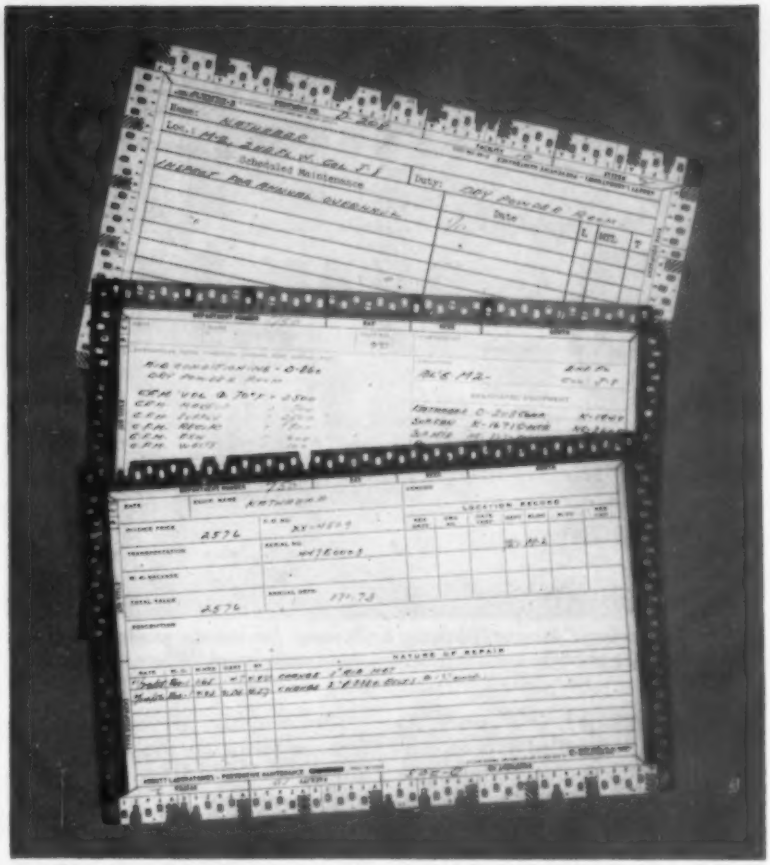
Detailed checks planned

Scheduled maintenance calls for more detailed checks, sometimes including dismantling to determine amount of wear on bearings, state of valves and packing, and so on.

Program enables maintenance engineers to find instantly every wanted fact about each unit — each blower, each fan, each compressor, each humidity conditioner. Facts can be determined as easily on any one part as on the whole of each system.

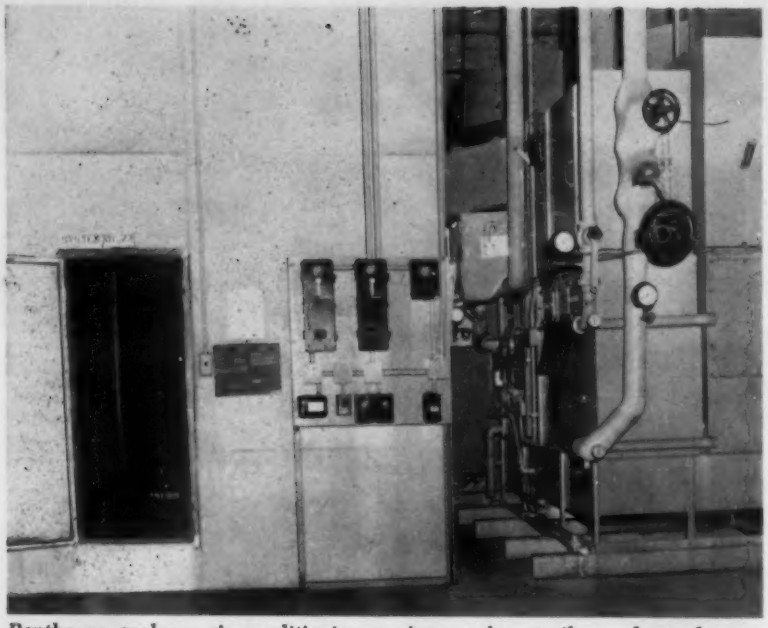
Program is worked out through a simple, yet comprehensive punch card system. All cards pertaining to components of a single unit have a common color or punch. Each card for all components of a complete system are similarly segregated. Every Friday afternoon, each set of cards is pulled. They are pin-sorted (see illustrations) to cull out cards that are prepunched to fall out on the Friday in question. Cards that fall out carry all details of work to be done the next week. Corresponding pre-written work orders are pulled from files and given to tradesmen. As jobs are done, punch cards and work orders are re-filed to await next Friday's sorting. They may or may not come out again the next week, depending on work they represent.

Cards are tied into Abbott's cost accounting system. All information gathered in these checks, either preventive or scheduled, is logged by maintenance clerks on forms that give management overall



Samples of punch cards by which Abbott maintenance engineers keep track of what should be done and what has been done to keep equipment in top shape.

Maintenance engineers Olson and Scott check American incoming air filter as part of scheduled semi-monthly inspection. All inspection data is logged.



Penthouse encloses air-conditioning equipment for sterile products department. Kathabar package humidity conditioning units supply filtered makeup air.

status of equipment at a glance. At the same time, detailed data on condition of the individual components is available from them. For instance, preventive maintenance reports on the solution used in the 15 Kathabar humidity conditioners show all model information, location of each unit, and job it is designed to do (in terms of relative humidity and temperatures to be maintained). Recorded periodic readings on solution condition include maximum and actual specific gravity, pH factor, and so on.

Semimonthly preventive maintenance forms on the general condition of humidity conditioners themselves provide space for abbreviated solution information, plus data on the regeneration steam valve and pump pressures. Again, space is given for special comments.

Scheduled annual December inspection of this equipment calls for checks of regenerator coil circuits, coil flushings, sump washing, testing of solution filters. It also calls for checking regenerator drive, coolant regulators, and controls. General checks are also made on regenerator air volume, fan, motor and drive, chamber housing, sump and float switch, pump and motor, solution filter, air filter, gages, and thermometers. Even unit's paint job is reported.

All work recorded

Work done on each humidity conditioner, air conditioner, refrigeration unit, or other component of the general system is recorded on the punch cards, along with cost in labor and materials. Cards are so keyed that engineers or cost accountants can quickly pull all information bearing on any one unit. Individual report forms are paired with each card for each inspection. Thus, in condensed form, the whole history of a system or unit — its maintenance cost, its comparative efficiency, and its "bugs" or idiosyncrasies can be found out in minutes. Quick decisions on any air conditioning problem are the rule.

Abbott engineers regard the practical results of this developing maintenance program as dramatic, even though the program is far from completion. A fair estimate is that the procedure has cut maintenance labor hours on most air conditioning equipment about 25 percent. Many problems formerly accepted as routine have disappeared. Downtime has been cut to the minimum — usually to the actual time scheduled for inspections — by the advance thinking and planning that this planned maintenance system has made possible.

Why ammonia compressors fail

STUDY OF approximately 500 ammonia compressor failures shows that all of the direct causes of failures fall into 17 categories, with nine of them accounting for 95 percent of all failures, and eight accounting for the remaining 5 percent. . . .

A more detailed analysis indicated that over 53 percent of all the failures studied were due either directly or indirectly to human error manifesting itself in either improper operation, repairs, or adjustment; lack of knowledge; or lack of attention, or maintenance. These underlying causes include: failure to maintain an adequate or clean supply of proper lubricating oil, failure to maintain valves, improper starting, and improper operation of shutoff valves in both the jacket cooling water system and the lubricating oil system. . . .

Direct causes of failure	*Percent*
Progressive crack or fatigue	30.0
Dirty, low, or unsuitable oil	20.6
Slugging by liquid ammonia	15.5
Loosening of parts	6.8
Excessive wear	5.6
Misalignment	5.5
Material or design defects	4.6
Faulty repairs	3.4
Faulty adjustment	3.0
All others	5.0

Lack of attention will result in irreparable damage of the cylinders and pistons, whereas if the scoring is detected early enough, it may often be removed with a minimum effort and expense by honing.

. . . Earl L. Kemmler
The Locomotive
Hartford Steam Boiler Inspection and Insurance Company

You can *DO IT YOURSELF...*

Electronic equipment maintenance

Earl Seagrave has worked in the field of industrial instrumentation since 1937. He has operated maintenance departments in several large chemical plants. Seagrave now plans instrument and control systems for the Textile Division plants of Celanese Corporation of America.

E. M. SEAGRAVE,
Instrument Engineer
Celanese Corporation of America

YOU CAN MAINTAIN electronic equipment in your plant to the same standards of service continuity as any other equipment if you have a competent electrician or instrument man — and if you give him just $700 worth of equipment to do the job. Just as design and construction of electronic equipment has advanced over the years, so have repair and trouble-shooting techniques developed. Even with today's complex equipment, maintenance is easier than ever. This is true partly because of design improvements that eliminate unstable and temperamental circuits, and partly because of the plug-in component concept. But equally important are the systematized trouble-finding methods now available.

These methods are not startlingly new. For the most part, they are applied common sense. They require only a few basic tools, a repairman with an understanding of electricity at the trade-school level, and good schematic diagrams of the equipment to be serviced. Complex electronic circuits can be repaired intelligently *without* detailed knowledge of the function of every component.

Tools that you will need for effective maintenance are not complex:

- A good tube tester is essential. It should accommodate the whole range of ordinary receiver tubes as well as the special types encountered in industrial work. Several good commercial models are available. Your tester should give "transconductance" readings, which are a measure of the vacuum tube's actual response to an input signal. Simple emission-type testers are not quite so satisfactory.
- A vacuum tube voltohmmeter with ac and dc scales is needed. Conventional milliammeter-type voltmeters are often useless for electronic work because the load imposed by the meter itself may interfere with the circuit being tested. Such meters themselves superimpose significant load upon the circuit under test.
- An inexpensive cathode-ray oscilloscope is a key piece of equipment. A 5-inch screen is optimum size. Good horizontal and vertical gain is required. Vertical amplifier should be capable of giving 1-inch

Give a good electrician or instrument man $700 worth of test equipment plus some know-how and you can use electronic gear with no maintenance worries.

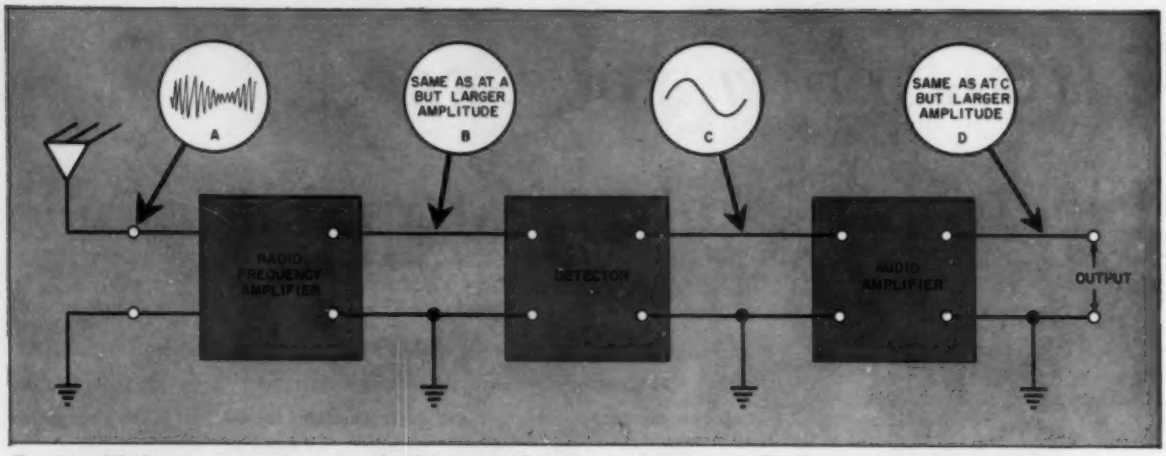


Fig. 1 — All electronic equipment can be diagrammed in terms of stages, or blocks, such as this ordinary radio set.

deflection for 0.05-volt signal input.

- An impedance bridge for testing capacitors and inductors is useful but not essential for most work.

These test equipment items, plus ordinary electrician's hand tools (including a small soldering iron), will cover almost any job. Just $700 will buy the test equipment including the impedance bridge. If purchased in kit form, the price will be nearer $375. These kits (which can be assembled as a fill-in job during spare time) are not only cheaper than the factory-assembled units, but they also provide a fine opportunity for the repairman assembling them to learn intimate details of operation and construction.

Specialists are available

Industrial electronic equipment repair specialists are occasionally available in the labor market. But we assume here that a full-time man is not required, and that someone now on the maintenance force will be assigned these duties. Almost every maintenance group has at least one man who is equipped with the ability and inclination for this work. Requirements are not as formidable as you might expect. An alert electrician, instrument repairman, or laboratory technician with a fair understanding of elementary electrical theory and a flair for trouble-shooting is a good candidate. Armed with manufacturer's repair manuals and a little experience, he will be ready for the most difficult jobs.

To use the testing methods we will describe, your repairman must have

- A complete schematic diagram of the equipment or system
- A normal voltage chart
- A list or chart of normal waveforms

Schematic diagram gives, in an easy-to-read form, the complete arrangement of the circuit — showing connections between components and values of resistors, capacitors, and other components. This diagram *must* be available if the equipment is to be serviced intelligently. (Equipment manufacturers have no standard policy for providing this diagram with maintenance manuals, which they do distribute routinely. If not provided as a matter of course, the purchaser should insist on receiving this diagram.)

Some charts obtainable

Chart showing normal voltages is often obtainable from the manufacturer, but the waveform chart is seldom provided with commercial equipment. It is necessary to prepare waveform and voltage charts yourself for each new piece of equipment for use in trouble-shooting later if these charts cannot be obtained otherwise.

Schematic diagram gives all the information required for testing components. *Voltage chart* permits checking voltage at all points indicated. But to apply the most useful trouble-shooting you must prepare a *block* diagram.

Block diagram systematizes the entire repair procedure and permits a logical approach to trouble-shooting. It is extremely simple in concept and application, but, unfortunately, is not as widely used as it deserves to be. Certain fundamentals show its usefulness: All electronic equipment has as its basic function the reception of an input signal and transformation of that signal to a usable output.

A simple radio receiver, for example, receives an input from its antenna in the form of weak electrical signals at high frequency, modulated by sound signals. Required output is an electrical signal of moderate voltage and of sufficiently high current to operate a speaker in conformance to the original, modulating sound signal. Necessary transformations take place in a succession of stages, each of which can be represented by a block (Fig. 1.) Each stage will, if in proper working order, give a predictable output for a normal input signal. If in testing, you *provide* that normal input, then the operation of each stage (which includes many components) can be checked by making measurements at one point only — the output terminals of the stage.

Describing input, output

To completely describe input or output from a single stage or function-block, voltage, frequency, and wave shape at the terminals must be specified. These three measurements are given instantly and in pictorial form by the oscilloscope, key tool for rapid trouble-shooting. Fig. 1 shows normal wave shapes

for each block as they would be displayed on an oscilloscope.

Preparing your block diagram

Experienced technicians may not actually record the block diagram for simple circuits with which they are quite familiar. For most work, however, it is best to prepare one carefully, ahead of time, with wave forms and voltages indicated clearly. Several guides are available in determining points that correspond to the input and output of each stage or function-block:

- Input to a function-block is nearly always applied to the control grid of the vacuum tube. Output is generally taken from the plate of the same tube.
- When two tubes are connected element-for-element in parallel, they should be considered together as one block.
- In nearly all circuits encountered with low-power equipment, the chassis forms one terminal of each stage's output and input circuit. It can be used conveniently as a reference point for voltage measurements and oscilloscope readings.

Many multipurpose vacuum tubes are used in modern equipment, so one vacuum tube may be shared by two blocks in your diagram. The separate functions of each section of the tube are usually clearly shown on the schematic diagram.

Schematics are easy

With these guides in mind, any technician who has proper schematic diagrams will be able to construct a block diagram very quickly after a little practice — remembering that each block includes a group of components that perform one operation on the input signal. The most common operations of function-blocks may be listed:

- Voltage amplification. Typical voltage amplifier found in most industrial equipment is the resistance-capacity-coupled type (Fig. 2.) Here five components and one vacuum tube combine to amplify a voltage signal. Description of exact operation of such amplifiers can be found in standard texts on the subject. But for our purpose it is enough to observe that the input is applied to the control grid of the vacuum tube and the output is

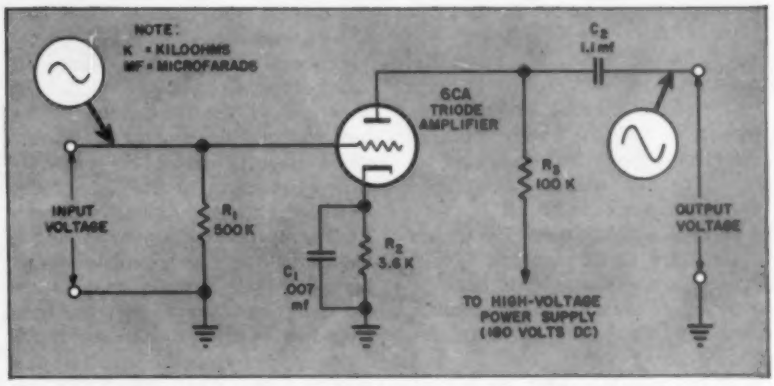


Fig. 2 — Typical voltage amplifier found in industrial equipment in resistance-capacitor-coupled-type, so designated by presence of R_3 and C_2.

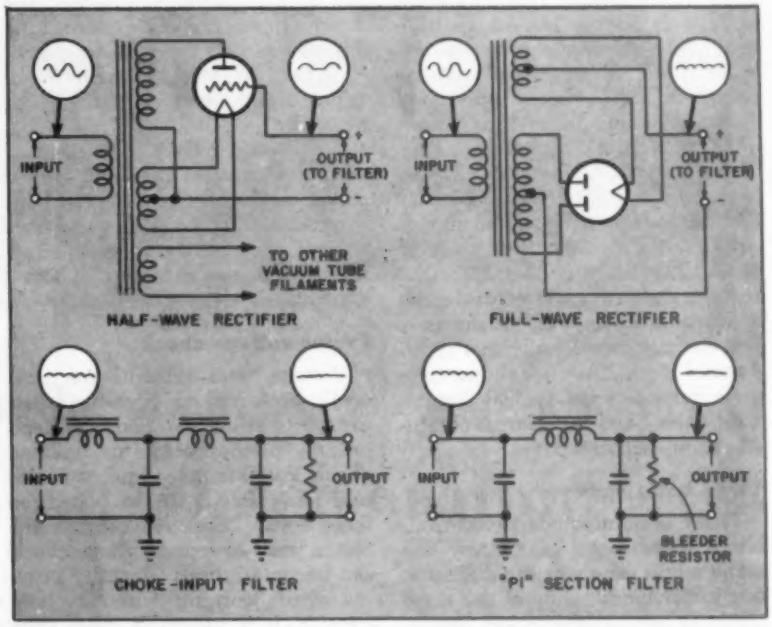


Fig. 3 — Power supplies and filters in industrial equipment are usually one of these types. Oscilloscope patterns afford quick, accurate test. Note how filters in circuit take rectifier output wave and smooth it out into steady dc current.

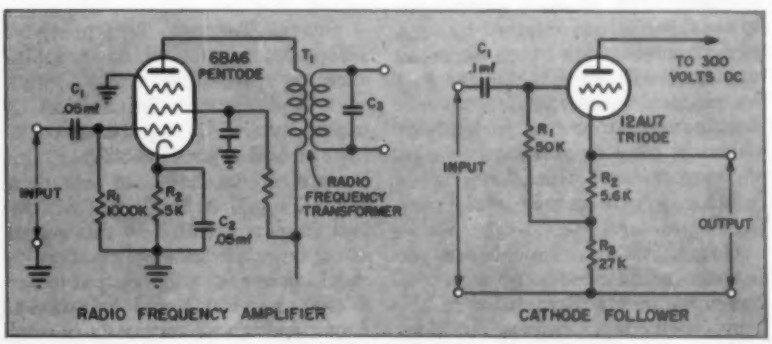


Fig. 4 — Radio-frequency amplifier is used in high-frequency circuits. Cathode follower operates to link high-impedance output to low-impedance input.

taken at the point indicated in the plate circuit.

Values of capacity, resistance, and voltage shown represent a typical circuit. Actual values vary widely as may the configuration of the circuit itself. But a voltage amplifier usually will be recognizable when compared to Fig. 2.

- Power amplification. Power amplifiers are often identical in configuration to voltage amplifiers, except that the resistance-capacity coupling used in voltage amplifiers is inefficient when large currents must be handled. This coupling is therefore usually replaced by a *coupling transformer*.
- Power supplies. Most circuits using vacuum tubes require a high-voltage dc supply for the vacuum tube plates. Power supply usually looks like one of the variations shown in Fig. 3. In low-cost, low-capacity units, inductance shown in the pi network filter may be, instead, a resistor. One of the capacitors may be eliminated. Bleeder resistor may or may not be included. Even so, the circuit will not be difficult to identify. Look for the rectifier tube with no control grid.
- Miscellaneous. Fig. 4 shows a few circuits occasionally met in industrial work. They are shown here for reference with typical component values and waveforms obtained on an oscilloscope.

Three basic methods

Three basic methods locate trouble in electronic gear. Any one alone might pin-point the difficulty, but judicious mingling of the three methods permits the expert repairman to find trouble both quickly and accurately.

- Component Test. This consists of merely measuring the special characteristics of each component to see if the values obtained by such measurements are the expected values. Resistors may be checked by physical inspection for obvious damage — such as broken leads or charring (due to excessive operating temperature). Actual resistance value may be measured in ohms by voltohmmeter.

Capacitors may be checked for leakage using resistance scales of the voltohmeter. Remember to observe polarity markings on electrolytic types. Vacuum tubes are checked in the tube tester using the instruction sheet that comes with the instrument.

Since all equipment failures are basically due to component failure, this method of testing alone will locate the trouble. Except in the simplest circuits, however, it is too time-consuming to disconnect and measure each component separately. Therefore, component testing is used early in the trouble-shooting procedure for certain easy-to-test items. (Checking a vacuum tube with the hand or eye to see if the filament is hot may be called a component test.) Again, near the end of the repair procedure, components testing is useful when the trouble has been localized to a narrow area involving only a few suspect components. These are then disconnected so they can be checked in turn. To quickly narrow down to the faulty area, use two other methods.

- Voltage and Current Check. If all voltages and currents are of proper value, the equipment will work. A check of voltages and currents is, therefore, equally as effective as component testing in locating trouble.

Prefer voltage check

Voltage measurements are generally preferred to current measurements since components need not be disconnected for voltage check. Voltohmmeter equipped with safe test prods is the tool used for these tests. Like the components test, a point-by-point voltage check can become a pretty lengthy process when working with involved circuits. It is generally used (like component testing) at the beginning and end of the repair procedure. Check of supply voltage is a simple and obvious first step in locating trouble.

- Signal Tracing. This method systematizes the whole trouble-shooting procedure and permits swift and accurate localization of the faulty area. It requires an oscilloscope and a good block diagram. Basis of the method is to provide a normal signal to the input of the first stage and to follow this signal as it "flows" from stage to stage — checking at each stage output to see if the expected signal is present. Any stage whose output is normal is, of course, in good working order.

When a stage with normal input and abnormal output is found, the trouble will be associated with that stage or components closely connected to it. Application of this procedure is just as simple as it sounds. If the block diagrams have been properly prepared and if the testing procedure is followed systematically, trouble can be localized to an area involving a very few components in a matter of minutes. After narrowing the search to one stage, voltage tests pinpoint the trouble. Suspect components then are disconnected, tested, and replaced if faulty.

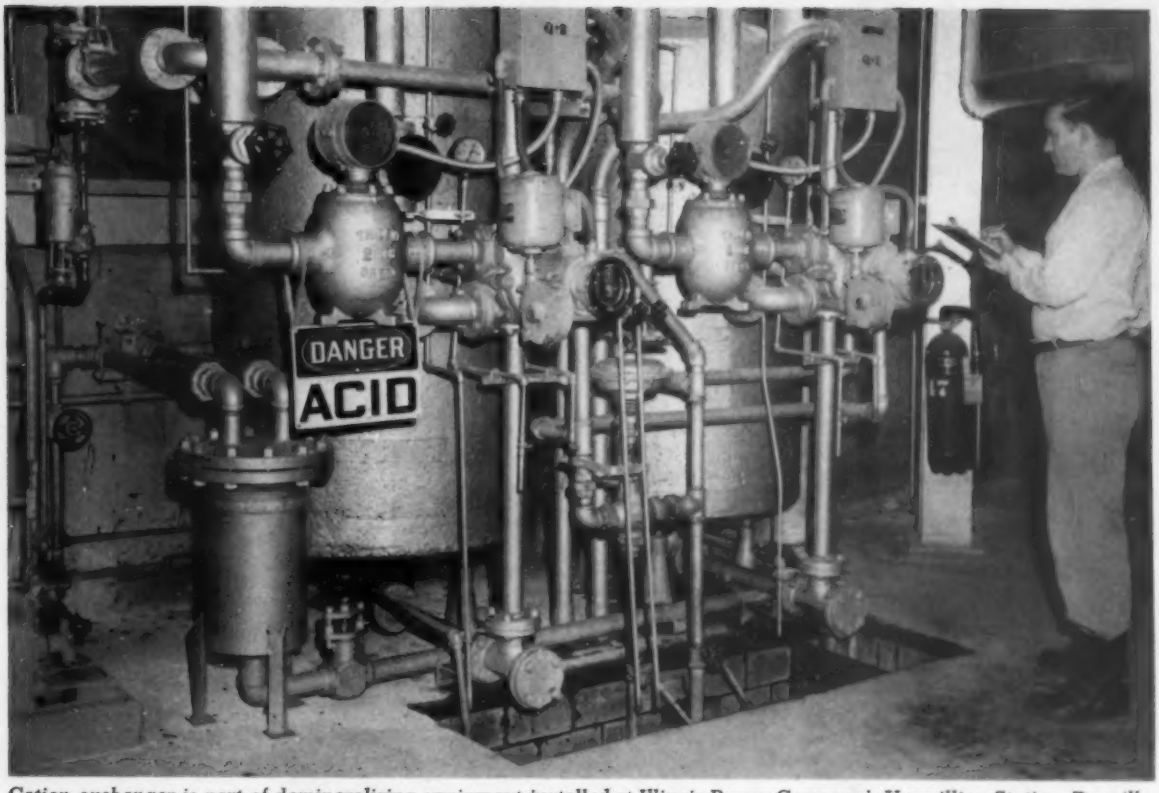
Signal tracing effective

Effectiveness of signal tracing using the oscilloscope is convincingly shown by considering the voltage amplifier in Fig. 2. If normal input is provided to this circuit and if the scope shows a normal output pattern, we can, by making this one measurement, check three resistors, two capacitors, a vacuum tube and the plate voltage supply.

Nearly every device encountered in an "average" plant has a straight-line signal flow from stage to stage. Each stage is one of the basic circuits listed earlier.

No matter what is written here concerning the ease with which repairs may be made to electronic equipment, it is obviously necessary for each plant to decide for itself just how much maintenance and repair it can economically undertake. This decision will be reached after a careful consideration of the number and nature of electronic devices involved, skill of plant personnel, availability of prompt outside repair service, importance of continuity of operations, and many other factors. Final decision could range from complete dependence on outside help, at one extreme, to completely independent repair facilities at the other.

Most plants find it advantageous to undertake all repair jobs themselves except those involving delicate electromechanical subassemblies. A modest inventory of spare parts combined with a fair understanding of electronic circuits can, when properly managed, produce a large measure of efficiency and satisfaction in performing maintenance tasks on today's indispensible electronic equipment.



Cation exchanger is part of demineralizing equipment installed at Illinois Power Company's Vermillion Station, Danville.

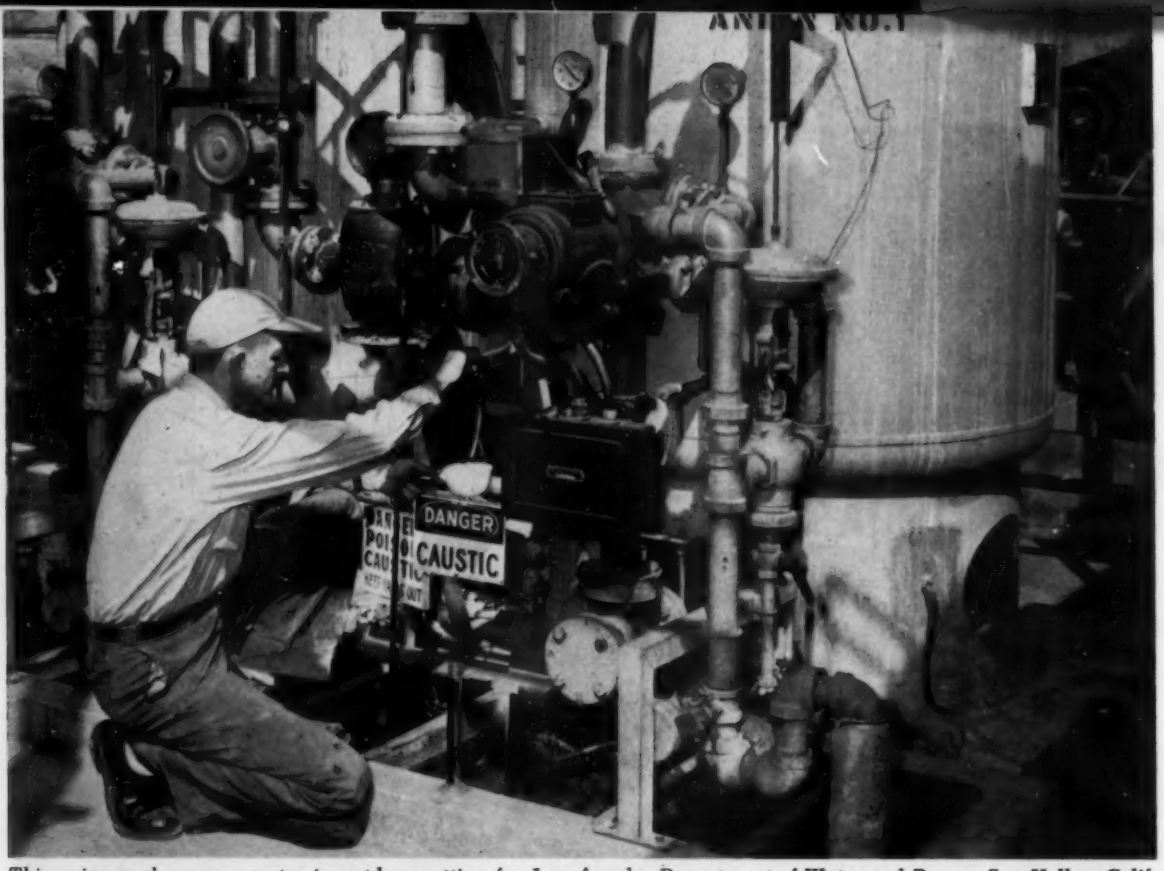
What to do about Anion Resin Deterioration

M. E. GILWOOD
Director of Research
The Permutit Company

YOU CAN GET longer resin life (which means less downtime) if you understand just *how* resins work, just *what is* in your water, and just what your equipment can *really* do.

Demineralizing process employing cation and anion exchangers is now well accepted for producing pure water. It has been adopted extensively for producing low silica, low electrolyte makeup for high-pressure boilers. When exhausted, the cation resin is regenerated with sulfuric acid. Acids formed in the water during the cation exchange reaction are then removed by further contact with a highly basic anion exchange resin. When exhausted, the anion resin is regenerated with sodium hydroxide.

Cation and anion exchange reactions can be done stepwise (successively one after the other) or simultaneously, (by mixed-bed treatment) depending on type of demineralizing equipment employed. Most power plants employ the stepwise process because it produces excellent low-silica demineralized water. The stepwise process is somewhat more foolproof, has better chemical efficiency, and a lower overall chemical treatment cost. Many chemical processing plants employ the simultaneous or mixed-bed process because they desire minimum conductive electrolyte content. Both treatments produce substantially the same effluent silica. Extent of use for multiple-bed and mixed-bed demin-



This anion exchanger operates in outdoor setting for Los Angeles Department of Water and Power, Sun Valley, Calif.

eralizers is indicated in Table I.

Cation exchangers, for the first step of the demineralizing process, are quite stable and require only minor replacement over years of normal use. Highly basic anion exchange resins, however, deteriorate more rapidly, require greater replacement and are more expensive. As a result, the problem of anion exchanger resin deterioration has received much investigation.

Commercially used highly basic anion exchange resins acquire their ion exchange characteristics from the quaternary amine groups in their molecular structure. Quaternary amine groups are incorporated in an insolubilized resin matrix. The most popular resin matrix presently employed is insoluble (crosslinked) polystyrene. Porosity of these resins can be varied by the amount and type of crosslinking (or insolubilizing) agents.

There are two fundamental types of polystyrene anion resins commercially available:

- In the Type I resin, all the carbons attached to the quaternary nitrogen are alkyl groups such as methyl (CH_3) and ethyl (C_2H_5).
- In the Type II resin, alkanols are present in the quaternary structure (such as methanol CH_3OH and ethanol C_2H_4OH).

Type I and Type II resins have somewhat different characteristics in operation. Type I resins produce a lower effluent silica in the treated water. This is especially evident when treating waters that have a high proportion of silica anions. Type I resins are substantially stable in long-term use when treating waters free of fouling contaminants (Fig. 1). Type II resins exhibit much higher operating capacities when new, and consume less caustic soda per kilograin of anion removed from water. Selection of one resin in preference to another is based on all these considerations.

Type II resins lose capacity in long-term use because of breakdown of the alkanol-type quaternary amine groups, even when used with comparatively pure waters. Some tests have indicated that this deterioration is accelerated by the presence of dissolved oxygen in the water being treated. Our own and other investigations do not confirm this, however.

It has been found after several years' experience with demineralizing installations that at some plants there are water contaminants which give a further decrease in exchange capacity beyond that expected. (Fig. 1). Such contamination or fouling occurs with both Type I and Type II anion resins. Although contamination is encountered at only a minor percentage of plants, it requires consideration, especially where surface-supply water is to be treated.

These contaminants have some effect in fouling anion resins:

- Traces of iron and manganese in the influent water to the anion exchange unit or mixed bed demineralizing unit precipitate in the

TABLE I

NUMBER OF DEMINERALIZER INSTALLATIONS

Anion Exchanger	Multiple Bed	Mixed Bed	Total
Weakly Basic	1,245	5	1,250
Strongly Basic	325	467	792
Total	1,570	472	2,042

molecular pores of the resin and interfere with diffusion of anions into pores of the resin granules. Difficulties with iron and manganese precipitation are more frequently encountered in mixed-bed demineralizing if the water entering the unit is not pretreated to remove these contaminants. In the stepwise demineralizing process, the hydrogen cation exchange unit minimizes the amounts of these contaminants in the influent water to anion resin.

- Metal cyanide complexes such as copper, nickel, and cobalt cyanides are adsorbed on the anion resin almost irreversibly and interfere with anion exchange. These impurities are present sometimes in surface streams polluted with electroplating wastes. If present in small amounts, they are generally completely removed by the cation exchange unit in stepwise demineralizing plants. They can cause difficulty in mixed-bed demineralizing plants unless suitable water pretreatment is employed.
- Industrial organic contaminants like high molecular weight carboxylic acids, reactive organic acids, and so forth.
- Dissolved organic compounds of natural origin. These are of many varieties and arise from the bacterial decomposition of the common organic impurities leached from soils, decaying trees, and leaves.

Fouling of anion exchange resins is more of a problem in mixed bed demineralizing plants than with stepwise demineralizers. There are several reasons for this:

- In stepwise demineralizing, some harmful contaminants are removed in the first stage cation exchange treatment before the water reaches the anion resin. This has been found not only with iron and manganese, but also with organic contaminants on some waters. Less difficulty has been reported with anion resin deterioration in a two-step demineralizer than in a mixed-bed demineralizer used on a specific water.
- Mixed-bed demineralizing plants are usually installed where it is desired to obtain the lowest conductive electrolyte content in the treated water. With new anion resins in a mixed-bed demineralizer, it is readily possible to obtain treated effluent containing 0.05 to 0.2 mmhos/cm conductivity. Most often, mixed-bed demineralizers are expected to deliver water having a maximum conductivity of from 0.2 to 0.5 mmhos/cm. On the other hand, most stepwise demineralizers are designed to produce a treated effluent having a conductivity of from 5 to 15 mmhos/cm. Anion resin fouling is usually evidenced by a decrease in length of demineralizer runs. When organic fouling occurs, the resins become loaded with organic acids. Leakage of these acids produces an increase in conductivity and a reduction in pH. These small increases in conductivity normally are not noticeable in stepwise demineralizers. Residual silica from the demineralizer remains satisfactory (0.01 to 0.1 ppm SiO_2), even when fouling increases effluent conductivity.
- In stepwise demineralizers, the only effect of such fouling is to reduce exchange capacity of the resin, increase rinse time, and reduce average effluent pH from the usual range of about 8.5 to 9.0 to the range of 5.0 to 7.0.

To extend anion resin life when treating such contaminated waters, these contaminants must be substantially absent from the water entering the anion unit. Most often, well waters are reasonably free of these contaminants except for iron and manganese. These can be removed from water without much difficulty.

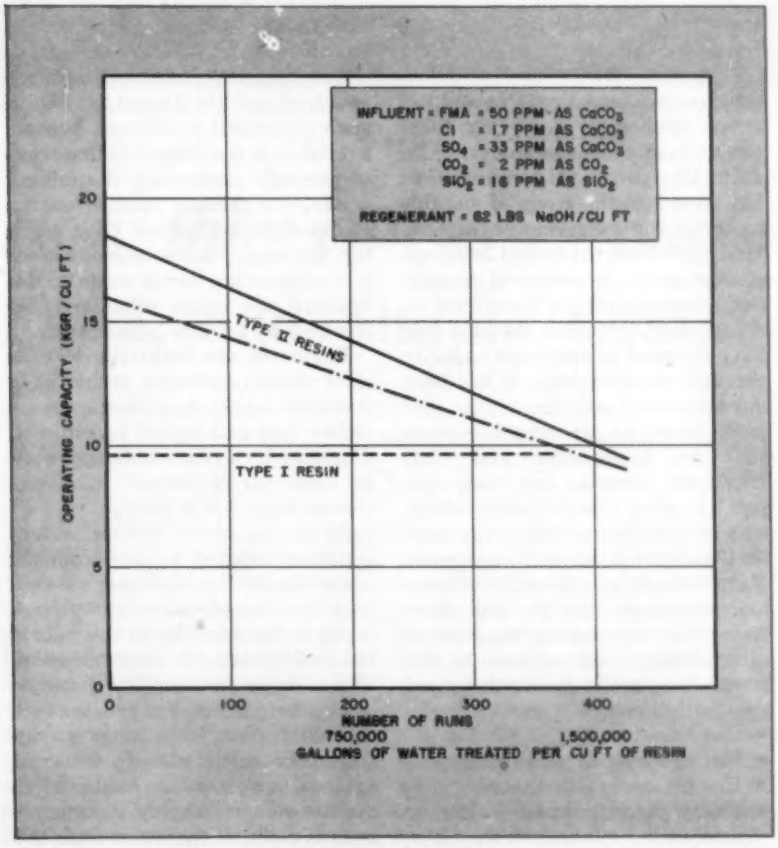


Fig. 1—Deterioration of Type I and II resins during treatment of well water. Type II resins lose capacity because of breakdown of quaternary amine groups.

Contaminants in surface waters

Many surface supplies, even those purified by the conventional coagulation and chlorination treatments, contain appreciable amounts of organic contaminants. Most of these contaminants are not adsorbed and do not appear harmful to the anion exchanger resin. Some are adsorbed so strongly by the quaternary amine, however, that they are not released during regeneration. In water supplies where this is the case, anion resin fouling will occur. Unfortunately, the various organic compounds in water

are not easily identified or analyzed. Accordingly, they are not reported in the standard analyses of surface waters.

In the usual water analysis, guides to organic content level are:

- Color
- Permanganate consumption
- Chlorine demand
- Ether extraction
- Albumenoid nitrogen

None of these criteria has proven a guide to the tendency of water to foul an anion exchanger. The various organic compounds are extremely difficult to distinguish without laborious, expensive, and time-consuming analyses. It is not possible, therefore, to predict the tendency of a given surface water to produce anion resin fouling. Only method presently known for such prediction is to treat such water for a period of time in a demineralizing plant (or small-scale miniature) to determine if the water has a tendency to foul anion resins. As experience is accumulated on various surface supplies, a list of waters that foul anion resins badly and of waters that do not is being accumulated. Efforts along this line are being made by water treatment engineers.

Adsorbents are successful

Adsorbents have been the only successful method for removing harmful organic contaminants from surface waters. Some of these adsorbents are:

- Activated carbon
- Aluminum hydroxide flocs (produced by coagulation of alum)
- Highly porous anion exchange resins.

Pretreatment of water by activated carbon filters has been investigated and has prolonged anion resin life when used on some waters. It has been found necessary, however, to provide steam treatment of the granular activated carbon every day or two to maintain its effectiveness. Even where it is effective, pretreatment with activated carbon has not been successful in completely stopping anion resin fouling on some waters tested.

Pilot plant tests are underway to determine the effectiveness of powdered activated carbon pretreatment in a sludge-contact-type coagulation unit. These tests will determine if such treatment, in conjunction with alum coagulation, will provide adequate anion resin protection against fouling.

Removal of humic acids from water by adsorption on alum coagulation floc has been done for a long time. Experience has indicated the desirability of large doses of alum to obtain more complete removal of these organic contaminants. Tests have been made to determine the effectiveness of high-dosage alum coagulation and alum-floc contact prior to demineralizing.

Reports on adsorbent tests

Tests have been reported in which a highly porous anion exchange resin bed was used as an adsorbent for organic contaminating compounds to protect the highly basic anion resin used in demineralizing. Such pretreatment is expensive and of questionable value. The anion exchange adsorber bed is occasionally regenerated with hot brine solution to restore its activity. Contradictory reports regarding the effectiveness of this treatment have been made.

Difficulties have been encountered in obtaining a reliable and fool proof method of removing these contaminants or even analyzing for them. Consequently, much effort has gone into the study of suitable methods for removing these contaminants from the fouled anion exchange resins. A variety of restoration treatments have been tried on anion exchange resin samples that have dropped in exchange capacity through contamination. It has been our laboratory practice to first give such resins a prolonged contact with hot hypochloric acid. This treatment removes any iron, copper, or other heavy metals which may be interfering with proper operation of the anion exchange resin. If the resin is not restored to its normal exchange capacity and effectiveness by this treatment, additional treatments are applied to the resin. Among the treatments used are the following:

- Hot brine
- Hot brine — hypochlorite
- Hot brine — sulfuric acid
- Thirty-percent warm sulfuric acid
- Hot brine — nitric acid
- Formic acid and sodium formate
- Hydrogen peroxide
- Chromic acid
- Organic solvents

All except the first two of these treatments have helped on resins contaminated with organic compounds. None of them is completely effective. Further, a treatment which is most suitable on a resin contaminated with one water supply is not always most effective on resin contaminated with another supply.

On the basis of these various tests, we generally recommend that fouled anion resins be given a hot brine-cold acid treatment. If this is not effective, we then suggest a hot brine treatment followed by 0.5 percent sodium hypochlorite solution. Care must be employed in applying hypochlorite treatments to the highly basic anion resins because excessive use of hypochlorite has led to deterioration and reduction of resin capacity.

Further research is necessary

Because available treatments do not usually restore the anion exchange resins to their original exchange capacity, further efforts are required in this direction. Until such successful treatments become available, it is essential to find ways of properly pretreating the fouling water — to remove trouble-making contaminants before they reach the anion exchange resins. Extensive studies are being made to determine the most effective pretreatments in this connection.

Engineers are beginning to consider anion exchange resins as a chemical supply operating expense rather than as a capital investment. This may be a reasonable approach at those plants where anion exchange resin life is short.

At plants where surface waters are being treated, anion exchanger units should be selected so that units will supply adequate treated water if the capacity of the unit is reduced by organic contamination. Where large demineralizing installations are being contemplated, tests on the available water supply should be made on experimental equipment as soon as possible after the decision to employ demineralizing is made. If the water fouls the anion resin rapidly, pretreatment of the water should be provided.

Explosions and fires can be the result of ignorance or disregarding hazards of handling fuels and flammable liquids.

How they start . . . Explosion, Flash, and Simple Combustion

ROBIN BEACH, Consulting Engineer

SPARK-IGNITION hazards; flammable mixtures of gaseous, liquid, and dispersion fuels; and the ignition energy necessary in electrostatic sparks to cause fires or explosions where flammable mixtures exist — these are essential elements you must understand if you are to handle industrial fuels safely. Three primary components necessary to initiate any fire or explosion are shown in their relation to one another by the explosion triangle. These three elements — fuel, oxygen, and ignition — are so related to each other that they must all be present in the requisite proportions at the same time and in the same space if fire or explosion is to occur.

To illustrate, mixtures of fuel vapor and air in proportions to give flammable mixtures often exist in many areas of a plant. This, of course, is a hazardous situation that should not be permitted to exist. No untoward effects occur, however, in any such hazardous zone unless an igniting source containing sufficient heat energy to start combustion is available.

Thus, the base line of the explosion triangle relates two components required for a flammable mixture. Fuel may be in liquid, gas, or solid form. Consider these three forms of fuel in detail. Obviously, gas can readily be mixed with air to provide a flammable mixture. Of the many fuel gases and gases used for other purposes, hydrogen is one of the most potent in forming

an inherently explosive mixture.

On the other hand, liquid fuels are not directly flammable as such. Rather, they provide vapor which must be mixed with air in proper proportions to yield combustion. For example, a spark plug can be submerged in any liquid fuel and be sparked without causing ignition. Liquid fuel first must produce vapor from its surface, which then must be mixed with air in proper proportions, before combustion can take place. When vapor is combined in correct proportions with air to form a so-called "explosive mixture," the mixture may be ignited by the application of heat, such as exists in electrostatic sparks.

Likewise, solid fuel cannot be ignited or burned as such until it has been sufficiently heated to produce adequate vapor to mix with air to form a flammable mixture. Or solid fuel must be pulverized so that it can be blown with air to yield an explosive mixture.

Sometimes, instead of mixing air with flammable vapor or gas to create a flammable mixture, pure oxygen is used in place of air. Lack of the nitrogen diluent (present in air to the extent of 75.5 percent nitrogen to 23.2 percent oxygen, by weight) imparts marked increase in the flammable sensitivity of the mixture by greatly increasing the extent of its explosive range. Combining pure oxygen with ether, for example, more than doubles the upper explosive limit of combustion. That is, air mixed with ether has an explosive range, by volume, from 1.85 percent to 36.5 percent. When mixed with pure oxygen, the explosive range extends from 2.10 percent to 82.0 percent. For cyclopropane, pure oxygen extends the upper explosive limit almost 600 percent as compared to air. Though these vapors and gases happen to be anesthesia agents, nevertheless they clearly illustrate that oxygen makes any gas or vapor much more susceptible to explosion.

Explosions defined

Fires occur only when the ignited flammable mixture occupies but a relatively small portion of the enclosed space. On the other hand, *explosions* take place when the ignited flammable mixture pervades the entire enclosure. Explosions of minor destructive force, however, may result when only a part of the room contains an ignited flammable mixture. In this instance, a pressure wave is propagated that strikes with comparatively less force against all bounding surfaces of the room. Such a situation might occur from spilling a considerable volume of flammable liquid, or by the sudden rush of gas from a pressurized gas cylinder in which the flammable mixture becomes ignited.

Several physical properties relate to safe handling of industrial fuels:

One such property is *flash point*. Flash point indicates the lowest temperature at which a flammable liquid emits sufficient vapor to yield a flammable mixture with air. Flash point is determined through test by heating the liquid within a standard container until it provides sufficient vapor when mixed with air to flash when a lighted taper is applied to it. The standard container may be closed or open. Flash-point temperature taken by the closed-cup method is higher than open-cup flash point of –50 F. At ordinary fuel oil is about 150 F for the closed-cup test, and 320 F for the open-cup test.

Flash points are danger points

Some liquids have flash points far below ordinary room temperatures. Gasoline has a closed-cup flash point of —50 F. At ordinary room temperature, a cupful of it will evaporate in about five or six hours. On the other hand, a fuel such as kerosene, having a closed-cup flash point of 150 F, would remain at room temperature almost indefinitely without appreciable evaporation.

Liquids whose *boiling point* is well below ordinary room temperature yield vapors termed gases because they exist only in vapor form at ordinary room temperature and pressure. Anhydrous ammonia, for example, has a boiling point of –37 F. Thus, it is rated as a gas. When compressed and cooled to liquid, it returns to its corresponding low temperature.

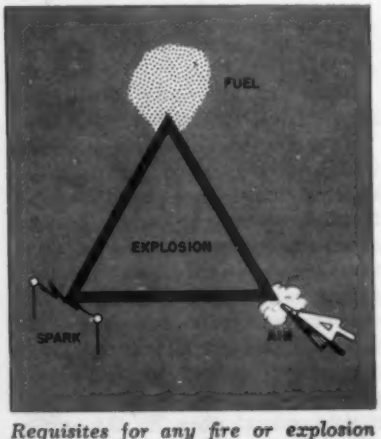
Particularly important is the physical property of *explosive limits*. Values are expressed in *percent by volume in air*. For kerosene, the explosive limit ranges from 1.16 percent to 6.0 percent. If a mixture of kerosene vapor with air is below 1.16 percent, there is insufficient fuel to provide combustion. Such a mixture is "too lean" to burn. On the other hand, if the mixture has fuel beyond the six percent limit, it is "too rich" to ignite and burn. Every flammable liquid and gas has upper and lower explosive limits. Some liquids, however, contain so many supplemental component elements, which vary widely within their compositions, that it is impractical to give any reasonable statement of their explosive limits.

Auto-ignition spells trouble

Another important physical property is *auto-ignition temperature*, commonly expressed in degrees Fahrenheit. This temperature is the lowest value at which combustion will start and continue in the absence of spark or flame ignition. Ignition is started by heating the flammable mixture. When ignition occurs, the minimum temperature at which the ignition starts is the *auto-ignition temperature*.

Auto-ignition temperatures of Nos. 1 to 4 fuel oils are 490 F, 494 F, 498 F, and 505 F, respectively. All these values are remarkably low. To illustrate how low, compare them with such highly flammable products as gasoline at 495 F, methane at 999 F, hydrogen at 1076 F, benzene at 1076 F, and carbon monoxide at 1204 F.

Still another important property relating to flammable mixtures is



Requisites for any fire or explosion are fuel, oxygen, and ignition source.

vapor density. Vapor density is expressed as a ratio with air taken as unity. Vapor densities of all flammable liquids are heavier than unity. For example, vapor density of kerosene is 4.5, kerosene vapor being 4.5 times heavier than standard air. This property accounts for heavy vapors falling rapidly to floor level, spreading extensively about, and sometimes causing flash fires to travel several hundred feet from the point of ignition. Many gases, in contrast to vapors from liquids, possess a vapor density considerably less than air. Illuminating gas may range from 0.4 to 0.9, with 0.65 being a representative average.

Properties are listed

All these and other physical properties for over 600 flammable products are incorporated in Loss Prevention Bulletin No. 36.10, "Properties of Flammable Liquids, Gases, and Solids," published by Factory Mutual Engineering Division. Anyone with responsibilities relating to potential fire or explosion hazards would find a copy of this pamphlet, or its equivalent, most convenient and helpful. Other tables are readily available showing these properties for fuel oils and mineral lubricating oil.

Fuels covered thus far have been gases or liquids, without mention of flammable solids. Solids, to ignite readily, must be put into dispersion form. Examples are powdered coal and metal dusts. In fact, almost all dusts are capable of ignition, fire, and explosion. Electrostatic sparks have been accountable for causing fires or explosions in grain elevators, feed and cereal mills, flour mills, starch and corn products plants, pitch and rosin plants, mines, and ordnance plants.

Dust explosions are treacherous

Upper and lower explosion limits for dusts are much more difficult to determine than for vapor or gas mixtures. Explosive limits of dusts are most commonly expressed in ounce measure per cubic foot of air. Coal, for example, has a lower limit in the order of 0.035 oz/cu ft and upper limit (which, at best, is only vaguely defined for any dust-air mixture) about 0.6 oz/cu ft.

Obviously, the minimum heat energy in an electric spark that will cause ignition of a flammable mixture is a property of ignition that is singularly important.

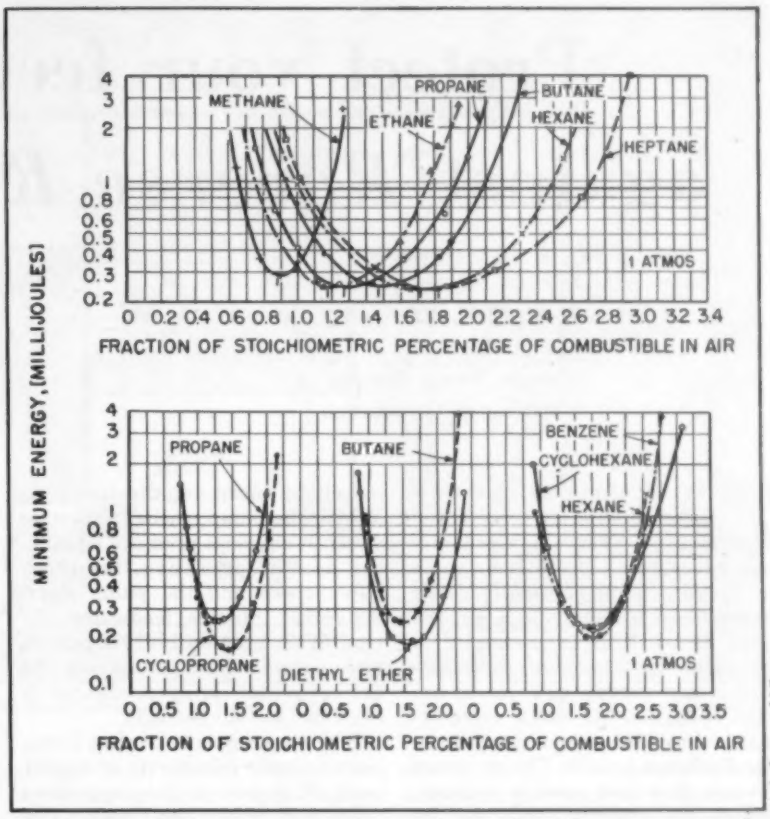


Fig. 1 — Threshold ignition energies vary for combustible mixtures in relation to varying proportions of flammable vapors and gases mixed with air.

Fig. 1 reveals the important properties of electrostatic sparks required to produce threshold ignition for several hydrocarbon gases and vapors under atmospheric pressure. Study of these properties shows the characteristic V-shape of the data resolved to graphical form. Threshold energy of ignition generally applies to the lowest point of the V-curve for the gas or vapor under consideration. In Fig. 2, threshold energy is seen to be the least possible spark energy to ignite the most favorable explosive mixture of the gas or vapor with air. In tests by which data for these V-curves were obtained, each point on a curve represents the minimum energy required to ignite that particular mixture of fuel vapor or gas with air. V-curves of this nature have been determined for only a few flammable gases and liquid vapors. These are largely of the hydrocarbon series. This experimental service has been conducted throughout the years chiefly in the laboratories of the U.S. Bureau of Mines. Fuel oils, for example, vary sufficiently from blend to blend to render inaccurate any attempt to publish their explosive limits, vapor density, and flash point.

Continued caution is the answer

Hence, if any particular fuel oil was responsible for fire or explosion, physical properties would have to be determined by special tests for that product. In the interests of *safety*, therefore, percentage of fuel vapor mixed with air should be maintained below 1/5 of the lower explosive limit. This means providing adequate ventilation. You must not be overly dependent on so-called "perfect ventilation," however, as no such system has yet been developed for industrial practice — nor is one likely within the near future.

Protect your feed pumps against *Reverse Rotation*

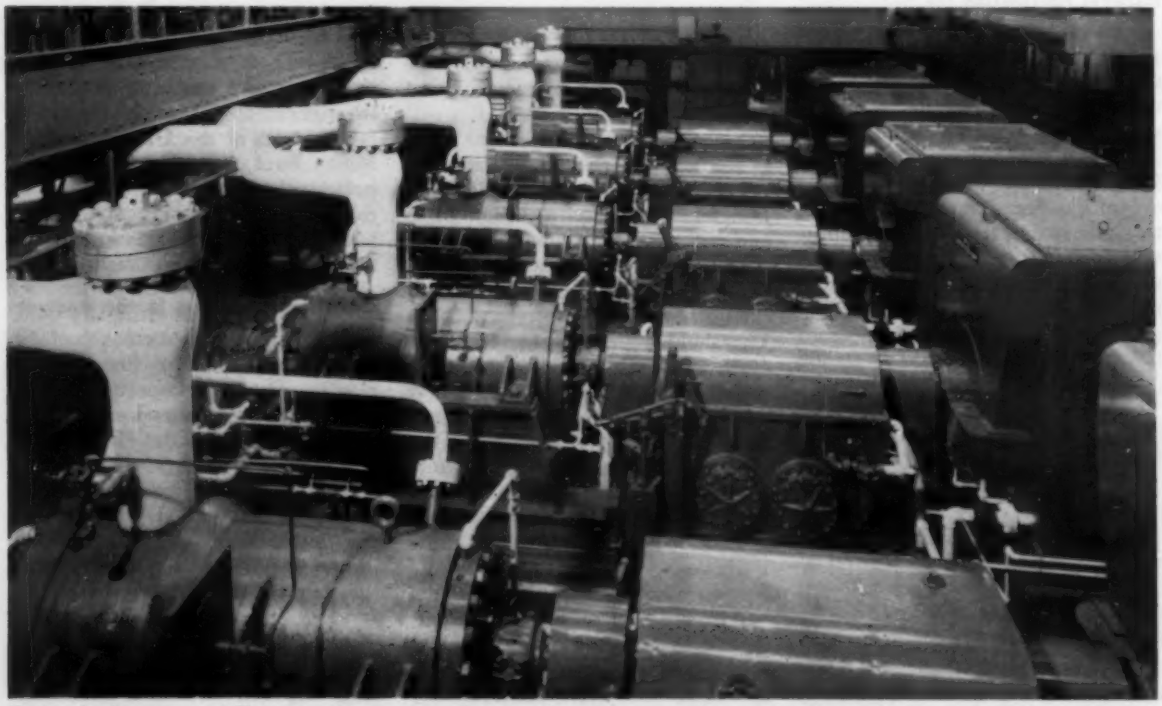
T. W. EDWARDS and
I. J. KARASSIK
Harrison Pump Division
Worthington Corporation

HOW DO YOU protect against reverse rotation of your boiler feed pumps? Every high-pressure boiler feed pump system has a spare or standby pump, normally ready to start at a moment's notice if the need arises. This is accomplished by valve arrangement. Both discharge and suction gate valves are kept open, and the check valve remains closed because of pressure in the discharge header. This prevents reverse flow and reverse rotation. Hence, the standby pump can be started from a remote location merely by energizing the driver. As soon as the pump reaches a speed at which it develops pressure equal to the header pressure, the check valve opens and the pump starts delivering into the feedwater system. With motor-driven pumps, time elapsed from energizing the driver to delivering feedwater is from two to four seconds.

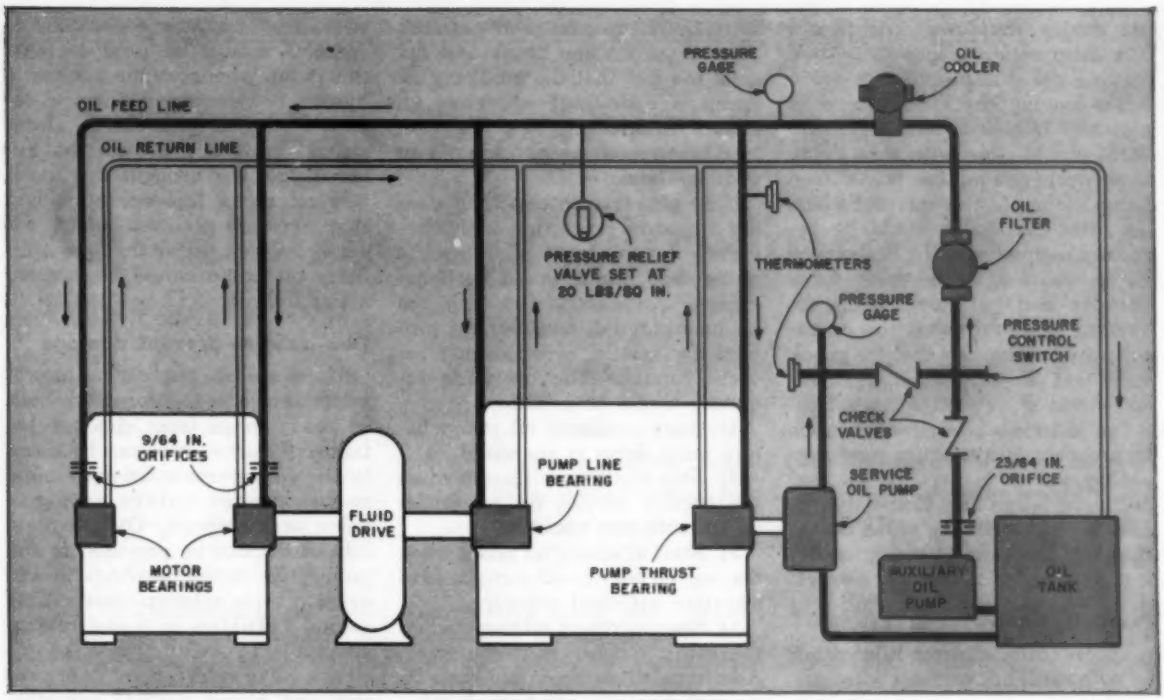
When a pump is to be shut down, power supply (electricity or steam) is cut off. As soon as the pump slows down sufficiently, the check valve in the discharge line closes, preventing reverse flow through the decelerating boiler feed pump.

This is what is *supposed* to happen. As every operator knows, once in a while the check valve fails to close or fails to close completely. When this happens, the damage that can occur to a boiler feed pump may be disastrous.

When a check valve remains fully or even partially open, the reverse flow past it and through the pump is quite large. Pressure upstream of the check valve is the discharge pressure of the pump or



Entire feed pump installation—prime mover, drive, and pump—must be protected against reverse rotation damage.



Lubrication diagram for boiler feed pump installation with common supply and return system using auxiliary oil pump.

pumps remaining on the line. Under these conditions, the deenergized pump will act as a turbine and will start rotating in reverse.

Actual reverse speed attained by the pump will depend upon a number of factors:

- differential pressure across the pump
- specific speed of the impellers
- relative opening of the check valve.

It may, however, reach up to 125 percent of rated pump speed.

There is no practical mechanical means in pump or prime-mover design to prevent this reverse rotation. Addition of a brake or similar device would be extremely cumbersome and costly.

Pumps designed for overspeed

Barring lubrication problems and possible damage to the driver (which must be considered separately, since this may be either a motor or a turbine), boiler feed pump itself should suffer no *direct* damage from reverse rotation. Pump design should certainly permit operation at 125 percent of rated speed because the pump is absorbing rather than developing energy.

Now, let us look at where the damage may occur. Generally, high-pressure boiler feed pumps have sleeve line bearings and a Kingsbury-type thrust bearing, all pressure lubricated. Oil is delivered to the bearings by a gear-type positive displacement pump, directly driven from the boiler feed pump shaft. When the pump runs backwards, no lubricating oil can be delivered by the service pump. Lack of lubrication will lead to burned out bearings and to *indirect* damage to the main feed pump. Failure to maintain proper alignment of close-clearance rotor parts will cause pump seizure and very serious damage. Where an integrated oil lubrication system provides oil to motor bearings, the motor may likewise suffer serious damage.

Let us, then, look into means to prevent reverse rotation of a boiler feed pump when the driver has been deenergized.

First of all, the discharge gate valve can be designed as both a check and gate valve built into one. This combination valve can be powered so that when the main boiler feed pump driver is deenergized, it closes at some predetermined rate and seats tightly. Closing rate or time delay should be controlled to prevent water hammer (from too-slow closure), or to prevent operation at complete shutoff without bypass protection (from too-rapid closure). One method to avoid either difficulty is to use a normal valve with follower to assure its ultimate and full closure. A valve similar to that used to protect the main steam turbine against reverse steam flow at extraction bleed points would be applicable here. This valve would have to be designed for water service and for the pressures and temperatures encountered.

Select best possible check valve

A simpler method of accomplishing a similar result would be to use a tilting-disc check valve, fitted with a dashpot to prevent slamming. Such a valve is possibly more reliable and more foolproof against hanging up than a piston-type valve. Valve element in a piston-type check valve fits into a recess in the body when the valve is open. If a particular boiler feed pump has operated for a considerable time, an accumulation of solids may restrict the clearances between valve body and valve element itself. Under these conditions, the valve element may become hung up and fail to give the desired leakproof clos-

ure during shutdown operations.

A third solution consists in motorizing the discharge gate valve while leaving the check valve as normally installed. This motorized valve would close with time delay after deenergizing the boiler feed pump motor. At the operator's leisure, the gate valve could be reopened manually so the boiler feed pump would again be ready for a remote-control start. Before reopening the gate valve, the operator would make sure that the check valve was properly seated. A further method of preventing reverse rotation in an idle boiler feed pump is to properly locate boiler feed regulating valves in each boiler feed pump discharge line. Complete closure of the regulating valve before stopping the pump eliminates dependence upon check valve closure.

Pump does not work in reverse

To reiterate, a direct lubricating oil pump will not perform when operating in a reverse direction. A motor-driven auxiliary oil pump is frequently installed to provide lubrication at startup and to act as standby if the direct-driven service oil pump fails to deliver oil for any reason. This motor-driven auxiliary oil pump is usually interlocked electrically with the main boiler feed pump motor. When the boiler feed pump is started, the auxiliary oil pump comes on the line immediately before the main motor is rotated. A pressure switch energizes the main motor only after a predetermined oil pressure is built up in the lubrication system. Time delay in this operation is generally from 10 to 20 seconds. When the direct-driven oil pump comes up to speed with the boiler feed pump, it develops a higher pressure than that developed by the auxiliary oil pump. This higher pressure shuts down the motor-driven auxiliary oil pump by actuating a pressure operated switch.

Pressure drop starts auxiliary

In the event of service oil pump failure, pressure in the lubrication system drops to a point where another pressure switch starts the auxiliary oil pump. A motor-driven auxiliary oil pump thus provides insurance against damage caused by service oil pump failure and consequent loss of lubrication. Failure to maintain operating oil pressure (due to an oil line break and despite the fact that the auxiliary oil pump is operating) energizes an electric interlock to stop the main feed pump motor and to actuate an audible alarm.

This electric interlocking does not provide protection under reverse rotation conditions, since the boiler feed pump would be deenergized. An electric interlock can be incorporated, however, to protect the system even against reverse rotation. The operating sequence would be as follows:

1) Start auxiliary oil pump before main drive is energized.

2) Stop auxiliary oil pump when the regular service oil pump develops sufficient pressure.

3) Start auxiliary oil pump when the regular service oil pump fails to maintain sufficient pressure.

4) Start auxiliary oil pump when the main driver is deenergized. Auxiliary oil pump would then be stopped manually after check valve closure is assured.

Final step most important

Note that the final step in this sequence is the important one in the event of reverse rotation.

There is still another method to actuate the auxiliary oil pump to prevent bearing damage due to reverse rotation. Large high-pressure boiler feed pump installations almost universally incorporate an automatic low-flow bypass for thermal pump protection at abnormally reduced capacities. Automatic bypass control is based on the installation of a flow measuring device in the boiler feed pump suction or discharge lines. This flow-measuring device has electric contacts that open the bypass valve at some predetermined low-flow condition and close the bypass valve when flow has increased sufficiently to prevent pump damage through excessive temperature rise. Since this flow-measuring device can be made to differentiate between flow in one direction and flow in another, it can be made to generate an electric impulse upon reverse flow. This impulse energizes the motor-driven auxiliary oil pump in the event of flow reversal which in turn provides proper lubrication.

Normal operating sequence for the auxiliary oil pump will remain unchanged, but an additional set of contacts should be used to start this pump whenever the automatic bypass flow-measuring device detects a reverse flow. Use an alarm signal to inform operators that reverse flow has brought the auxiliary oil pump into operation and that steps are required to stop reverse rotation. After this, the auxiliary oil pump would be stopped manually.

Two ways to prevent damage

There are two approaches to prevent damage to high-pressure boiler feed pumps from check valve failure. Positive steps can be taken to prevent reverse rotation by using motor-operated valves or other valve arrangements. Or, adequate lubrication can be provided to the pump and driver bearings in the event reverse rotation occurs. This second solution is more readily adaptable to existing installations where valve replacement is expensive and would require considerable downtime. Actually, addition of a motor-driven auxiliary oil pump can be made without shutting down the main unit. Work can proceed on the idle pump held on standby duty.

This kind of caution will allow installation of the required safeguards without lost time and with prudent minimum of expense.

Selection depends on your needs

Choice of the method to be used depends upon many factors that are peculiar to each installation and operating procedure. These vary from installation to installation. In the final analysis, however, good safety practices as well as good economic practices call for installation of one or the other of the prescribed methods.

Recognize that, under certain unfavorable circumstances, boiler feed pumps can operate in a reverse direction. This operation, though abnormal and rather infrequent, can damage pump bearings if allowed to progress to the point of seizure. This damage can cost many thousands of dollars. Keeping an eye toward increased boiler feed pump reliability compels that reverse rotation be eliminated or that protection against loss of lubrication during reverse rotation be provided.

Single-phase alternating current

Part IV

G. C. BLALOCK
Professor of Electrical Engineering
Purdue University

Start right here and now to brush up on your electrical background. Each article in I&P's Electrical Refresher will cover some basic facet of electrical engineering that will help you do your job better. Single sets of the complete Electrical Refresher series will be available without charge. Send in your request now and we will hold it until the complete set is available. Quantity prices upon request.

SINCE THE direction of the voltage induced by movement of conductors through a magnetic flux field—or the movement of magnetic flux across the conductors—depends upon direction of the flux field as well as direction of conductor movement relative to the field, voltages generated by a dc generator are initially alternating in character. Using a commutator, however, causes delivered voltage to be unidirectional so far as external circuits are concerned.

Ac generators, having no commutator, deliver the reversing voltage to the external circuits, reversing as the armature conductors move alternately across north and south magnetic poles—or as stationary armature conductors are subjected to flux moving across them, first from a north pole and then from a south pole. Because there is no commutator on an ac generator, it may have a stationary field structure and rotating armature coils, or it may have stationary armature coils and rotating field poles. Slip rings are required in either case. In all but the smallest sizes, ac generators are built with a stationary armature because of insulation problems involved.

By proper shaping of pole pieces, the armature may be made to generate a *sine wave* of voltage—this being the voltage wave most generally accepted as satisfactory. It is not achieved in all cases, but it serves as a model and is assumed to exist in most circuit calculations. Departure from true sine-wave voltage and current may be caused by the flux field shifting with variations in load, by pulsations in the magnetic field due to variations in magnetic circuit reluctance as the armature rotates, by rhythmic speed variations during the cycle, or by cyclic variations in circuit constants — resistance, inductance, and capacitance.

If we consider conductors A and B, Fig. 1, to represent the two sides of a coil rotating at constant speed through a uniform magnetic field, generated voltage plotted against time or angle for one revolution will yield a wave representing voltage for one *cycle*. Speed and flux density remaining constant, subsequent revolutions will give repetitions of the first wave. And if the circuit is completed through a load of some sort, current plotted from instant to instant will yield a similar wave. Number of such cycles per second, dependent upon number of

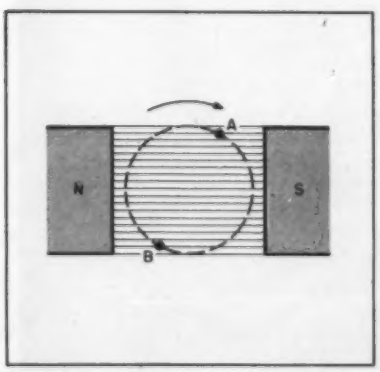


Fig. 1—Conductors A and B rotating at constant speed produce sine wave.

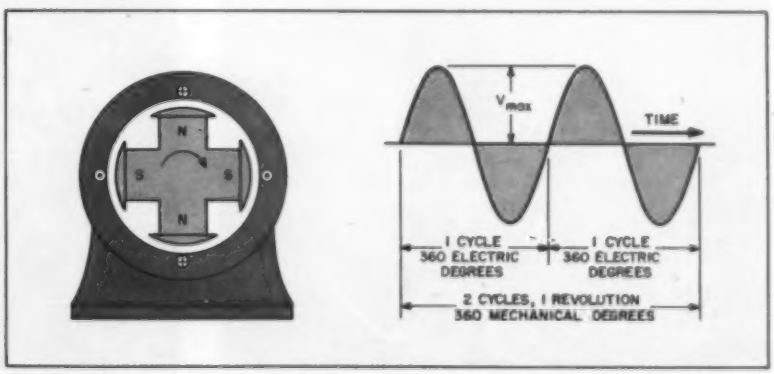


Fig. 2—Four-pole machine produces two cycles every revolution of rotor. Each pair of poles yields a full cycle in passing a pair of conductors.

poles as well as speed, is the *frequency* of the power supply. To generate 60 cycles per second, a 2-pole generator must have a speed of 3600 rpm. A 4-pole generator, Fig. 2, must have a speed of 1800 rpm—since one cycle is generated for each pair of poles. Required speed for a given frequency varies inversely as the number of poles.

Effective values

At any instant, the power dissipated by current flowing through a resistance of R ohms is i^2R watts —"i" being the instantaneous value of current. For each half-cycle, average i^2R, which is positive regardless of current direction. And average power multiplied by the time during which the current flows is the energy released in heat. Therefore, current equal to the square root of the average, or mean i^2, of the current wave is called the *effective value* of current. This is the most significant current value for use metering and in making calculations because this value squared and multiplied by R and t gives the energy involved in a given operation. This line of reasoning applies to voltage. Effective value of voltage or current, is directly comparable to the dc ampere or volt.

Root-mean-square (rms) value is the effective value of any recurring current or voltage wave, regardless of its shape. Rms is obtained by plotting a curve of squared values, determining the mean ordinate, and extracting its square root, Fig. 3. For a sine wave, the mean i^2 equals $I^2_{max}/2$. Rms value is equal to the maximum ordinate I_{max} divided by $(2)^{1/2}$. This may be expressed for current as,

$$I = \frac{I_m}{(2)^{1/2}} = 0.707I_m \qquad (1)$$

or, for a corresponding wave of voltage,

$$V = \frac{V_m}{(2)^{1/2}} = 0.707V_m \qquad (2)$$

Maximum instantaneous value of volts and of corresponding amperes may occur at the same instant, in which case current and voltage are said to be *in phase* with each other. In other cases, current may *lag* voltage, current passing through its maximum later than when voltage passes through its maximum. Under other circuit conditions, current may *lead* the voltage, its wave reaching maximum (or zero) ahead of the corresponding points on the voltage wave. In-phase condition would hold for circuits containing nothing but resistance. Circuits containing both resistance and inductance in appreciable amounts would cause current to lag behind the voltage, Fig. 4. Limiting amount of lag is one-quarter cycle, or 90 electrical degrees, this assuming that the circuit contained nothing but inductance. Correspondingly, for circuits containing only capacitance, current would lead the voltage by one-quarter cycle, or 90 electrical degrees. Circuits containing both resistance and capacitance would have current leading between 0 and 90 degrees, the exact angle depending upon the relative values of resistance and capacitance.

Inductance and capacitance have opposite effects in an ac circuit so far as phase relations are concerned, tending to cancel each other. Phase relations between voltage and current must be considered in determining power requirements of any circuit.

At any given instant, power input to an ac circuit is,

$$p = vi \text{ watts} \qquad (3)$$

where v and i are the values of voltages and current at the instant under consideration. Usually, it is average power rather than instantaneous power that is of greatest interest. This is expressed as

$$P = VI \cos \theta \text{ watts} \qquad (4)$$

where V and I are effective values (rms values) of voltage and current. Cos θ is the *power factor* of the circuit, θ being the angle of current lead or lag in electrical degrees (360 electrical degrees per cycle). Referring to Fig. 4, the power factor of the circuit with lag angle of 30 electrical degrees would be cos 30 degrees, equal to 0.866 and generally expressed as 86.6 percent power factor.

Power factor range

Since power factor is the cosine of the angle of lead or lag, its value will extend from 1.0 (or 100 percent) when the angle is zero (as in a circuit of pure resistance) to zero where the lead or lag angle is 90 degrees (as in a circuit containing nothing but capacitance or inductance). For pure resistance circuits, then, average power becomes the product of effective volts and effective amperes. A circuit having no resistance and containing only

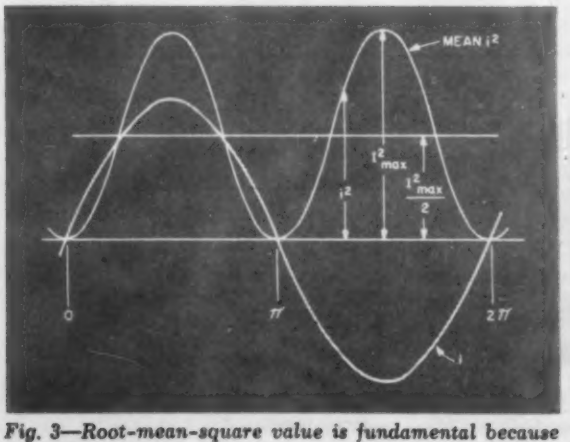


Fig. 3—Root-mean-square value is fundamental because it expresses effective values in terms of real energy.

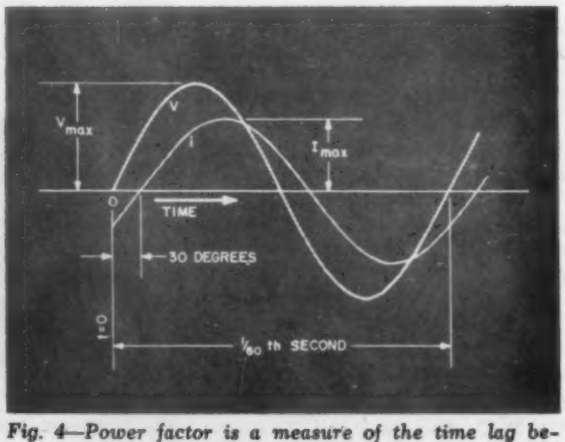


Fig. 4—Power factor is a measure of the time lag between waves of voltage and current in an ac circuit.

inductance or capacitance, would have average power of zero. This condition is a limit that may be closely approached but not reached since all circuits and connections include some resistance and absorb some energy, usually dissipated as heat.

Phase relations in a given ac circuit, as well as relative values of ac voltage or of current may be represented best by vectors. Vector resultant of two or more component voltage drops in a series circuit, or of two or more branch currents in a parallel circuit, represents the total voltage applied or the total current requirement. Any convenient *axis of reference* may be used, but it is usually more satisfactory to use the current vector as reference axis when dealing with series circuits, and the voltage vector as reference axis when dealing with parallel circuits. Power factor angles then coincide with the angles made with the reference axis, Fig. 5.

Parallelogram determines

With vectors draw to scale, completion of the parallelagram, Fig. 5, provides a graphical means of determining the resultant of two vectors representing like quantities—voltages or currents. Lead or lag angle of the resultant vector also may be measured from the diagram. Where more than two component vectors are to be added, any two may be added first. Resultant of these two is then combined with another until all components have been added. Final resultant represents the total voltage or current. Angle made by the final resultant with reference axis then represents the lead or lag angle for the entire circuit. Cosine of this angle is resultant power factor.

Vector quantities may be added mathematically by projection upon the horizontal and vertical axes. Horizontal projection of each vector is obtained by multiplying the vector length by the *cosine* of the angle it makes with the horizontal reference axis. Vertical projection of each vector is found by multiplying the vector magnitude by the *sine* of the angle it makes with the horizontal reference axis. Resultant is then the hypotenuse of the right-angle triangle formed by algebraically summing all the horizontal and all the vertical components.

Inductance opposes any change in current value. But current values are constantly changing in an ac circuit. So the effect of inductance in these circuits is significant. Effect of inductance, however, depends upon *frequency of the current* as well as upon the value, or amount, of inductance present. Ratio between voltage and current in a pure inductive circuit is written.

$$\frac{V}{I} = 2\pi fL = X_L \qquad (5)$$

where

f = circuit frequency in cps

L = inductance in henrys

X_L = inductive reactance, in ohms

Voltage drop across pure inductance becomes

$$V = IX_L = 2\pi fLI \qquad (6)$$

Inductive reactance effects are due to the counteracting voltages induced in neighboring coils or turns of conductor wire by the expanding and collapsing magnetic flux lines generated as the current grows or diminishes. Inductive reactance may be employed to limit or control current in a circuit. When used in this way, it has an advantage over rheostats in causing less heat energy loss.

Effect of pure inductance (a condition that can be approached as a limit when L becomes significantly greater than R) is to cause current through the inductance to lag the voltage drop by a full quarter-cycle, or 90 electrical degrees. Then, power factor approaches zero.

When a steady voltage is applied to the terminals of an uncharged capacitor, a charging current flows until the charge, or quantity of stored electricity, has reached a value proportional to the product of terminal voltage and capacitance. This is expressed

$$Q = CV \text{ coulombs} \qquad (7)$$

where Q = charge, in coulombs

C = capacitance, in farads

With a sine wave of voltage applied

$$I = 2\pi fCV = \frac{V}{X_C} \text{ amp} \qquad (8)$$

where X_C = capacitive reactance, in ohms

From this

$$X_C = \frac{1}{2\pi fC} \qquad (9)$$

Effect of capacitance alone in an ac circuit is again to cause quarter-cycle difference in phase between current and voltage drop. But with capacitance, current *leads* voltage by 90 electrical degrees. Power factor again approaches zero.

Thus, the two kinds of reactance — inductive and capacitive — have opposite effects upon power factor. When both are present in a given circuit, they tend to neutralize each other. Resulting power factor angle is determined by the algebraic sum of the two reactances. Inductive reactance is usually given a positive sign and capacitive reactance a negative sign.

Ohm's Law for ac circuits

Ohm's Law of the dc circuit may be applied in expanded form to include the three circuit properties

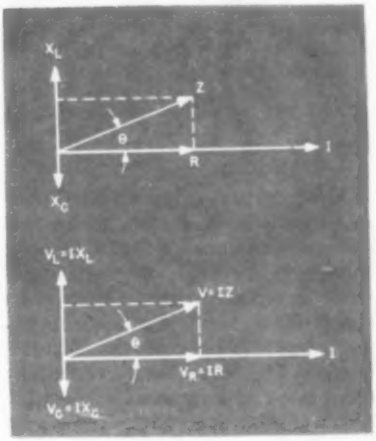


Fig. 5—Voltage and current are vectors, having quantity and direction.

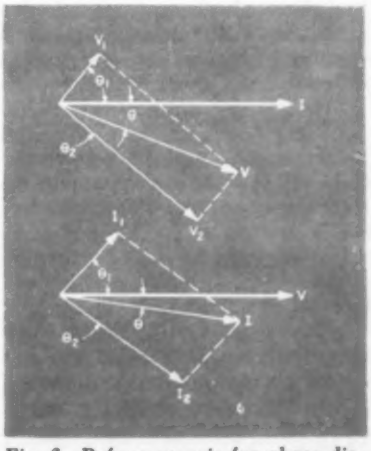


Fig. 6—Reference axis for phase diagram can be voltage or current.

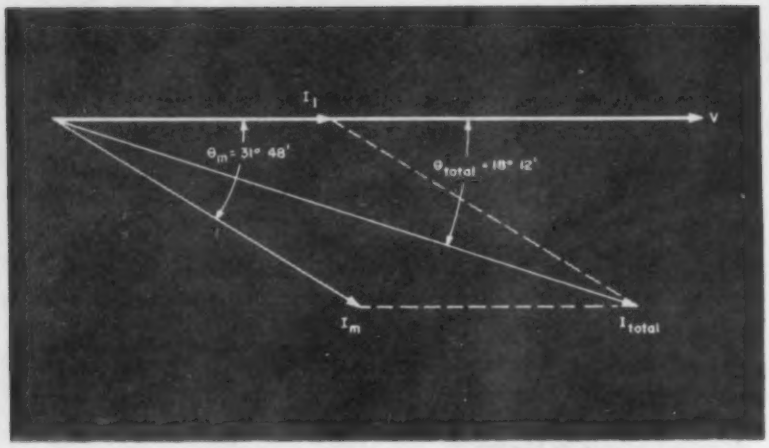


Fig. 7—Current drawn by lamps, I_l, is in phase with voltage, V. Motor current, I_m, lags. The total current, is the vector sum of its components.

that affect the ratio of volts to amperes in the ac circuit. Thus

$$V = IZ \quad (9)$$

where $Z = [R^2 + X^2]^{1/2}$ (10)

or $Z = [R^2 + (X_L - X_C)^2]^{1/2}$ (11)

which may also be expressed as

$$Z = \left[R^2 + \left(2\pi fL - \frac{1}{2\pi fC}\right)^2\right]^{1/2} \quad (12)$$

These relations may be shown graphically in the form of an *impedance diagram*, Fig. 6 (top). Power factor angle of the circuit is determined by the circuit constants R, X_L, and X_C. Lead or lag angle appears between the V and I vectors, Fig. 6 (bottom), regardless of reference axis used. Essential difference between Fig. 6 (top) and Fig. 6 (bottom) is that any reference axis may be used for the vector diagram (bottom), but the components R, X_L and X_C of the impedance diagram (top) are determined by circuit conditions and cannot be changed by reference to different axes.

Series circuits

Effects of the three properties, R, L, and C in the ac circuit, may be shown by use of a numerical example, as follows:

Given a resistance of 2 ohms, inductance of 0.05 henry, and capacitance of 80 microfarads all in series —with 220 volts at 60 cps applied to the circuit. Determine the resulting current and power factor—plus voltage drops across the resistance, inductance, and capacitance.

Solution:

$R = 2$ ohms

$$X_L = 2\pi fL = (2\pi)\ (60)\ (0.05) = 18.84 \text{ ohms}$$

$$X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 60 \times 0.000080} = 33.3 \text{ ohms}$$

$$I = \frac{V}{Z} = \frac{V}{[R^2 + (X_L - X_C)^2]^{1/2}} = \frac{220}{14.6} = 15 \text{ amp.}$$

$$\text{Power factor} = \frac{R}{Z} = \frac{2}{14.6} = 0.137 = 13.7 \text{ percent leading}$$

$VR = IR = 15 \times 2 = 30$ volts

$V_L = IX_L = 15 \times 18.84 = 283$ volts

$V_C = 1X_C = 15 \times 33.3 = 500$ volts

Note that the voltage drops across the inductance and capacitance are each appreciably higher in value than the applied voltage. But the *vector* sum of the IR, IX_L and IX_C voltage drops are equal to the applied voltage V.

When voltage drops across the inductive reactance and the capacitive reactance equal each other, they cancel each other. This condition may be reached by adjustment of the L and C values or by adjustment of the circuit frequency (since X_L varies directly with frequency for a given value of inductance and X_C varies inversely with frequency for a given value of capacitance).

Thus for the condition

$$X_L = X_C \quad (13)$$

$$2\pi fL = \frac{1}{2\pi fC} \quad (14)$$

$$f = \frac{1}{2\pi (LC)^{1/2}} \quad (15)$$

This condition of reactive equality in the series circuit is called *resonance*. It represents a generally undesirable condition in a power circuit because of the excessive voltages that may appear across component parts of the circuit. For this condition, values of IX_L and IX_C depend on the current flowing in the circuit. This is controlled only by the amount of resistance in in the circuit. IR drop under resonant conditions always equals the applied voltage. But for the *tuning* circuits in radio and other electronic equipment, resonance represents a sought-for condition.

Parallel circuits

For loads in parallel, which is the commonly used arrangement for motors, lamps, and other electrical equipment — voltage is common to all loads connected in parallel. Currents will be determined by the requirements of the various loads, and must be added vectorially to obtain the total, or line, current.

Given load on a 230-volt, 50-cps alternator consisting of 30 kw in incandescent lamps (considered to operate at 100 percent power factor) and a 40-hp motor operating at efficiency 88 percent and power factor 85 percent, lagging. Determine the lamp current, the motor current, and the total current, kw, kva, and power factor at the alternator terminals, Fig. 7.

Solution:

$$I_l = \frac{W}{V} = \frac{30{,}000}{230} = 130.4 \text{ amps lamp current}$$

$$I_m = \frac{(\text{hp})\ (746)}{(\text{V})\ (\text{eff})\ (\cos\theta\ \text{m})} = \frac{40 \times 746}{230 \times 0.88 \times 0.85} = 173.5 \text{ amps motor current.}$$

Total $I = [(I_l + I_m \cos\theta)^2 + (I_m \sin\theta_m)^2]^{1/2} = [(130.4) + (173.5 \times 0.85)^2 + (173.5 \times 0.527)^2]^{1/2} = 292.5$ amp.

$$\text{Tan}\,\theta = \frac{91.4}{277.9} = 0.329$$

$\theta = 18° 12'$

$\cos\theta = 0.95$

power factor = 95 percent lagging.

$$\text{kw} = \frac{230 \times 292.5 \times 0.95}{1000} = 63.9$$

$$\text{kva} = \frac{230 \times 292.5}{1000} = 67.3$$

Some ac loads, such as transformers and induction motors, cause lagging power factor. This can be compensated, wholly or in part, by adding capacitors or other equipment that operates at leading power factor.

In brief . . . .

Three air pollution conclaves

ASHAE Symposium

Six panelists conducted an Air Pollution Symposium lead by Prof. C. H. Pesterfield, Michigan State University, during the recent 62nd Annual Meeting of ASHAE in Cincinnati. Some 150 persons heard the Symposium, briefed by INDUSTRY & POWER for you here:

The growing air pollution problem

Gordon P. Larsen
Oxy-Catalyst, Inc.

"Very little work has been accomplished on the measurements of the gas-phase materials in the atmosphere or of reactions which occur in the mixtures which might be expected in every industrial area. . .

"Certain hydrocarbon vapors in sunlight and stable air can oxidize to form chemically complex aerosols and vapor-phase oxygenated hydrocarbons. Some of the latter are irritating to the eyes and cause damage to vegetation. The most important types of hydrocarbons which are known to play a part in this photochemical reaction are the olefinic, branched-chain and cyclic compounds — which are present in gasoline vapors. A byproduct of this photochemical reaction, where oxides of nitrogen are present in the atmosphere, is the production of ozone — which in itself may be irritating or have deleterious effects. . . .

"Confirmation of these findings in later years has lead to an intensification of studies on the sources of hydrocarbons. Auto exhaust, diesel engines, storage tanks, plating operations, and a variety of petroleum refining processes are being studied. Each of these sources of potentially harmful hydrocarbons or strong odors will ultimately be a major area of interest for every industrial community and for engineers engaged in improving atmospheric conditions either indoors or outdoors.

"While the work on controlling contaminants from these sources is relatively new, it is fortunate that sufficient information is available in the field to recognize that, in general, these contaminants can be removed by absorption or oxidation procedures. Consideration of this subject removes the engineer from the field of conventional designs employed in air pollution — such as electrostatic precipitators, centrifugal collectors, and filters. Here, the engineer is concerned with flame incineration, the use of catalysts for combustion, vapor recovery systems, and absorption. Each of these adaptations requires a specialized engineering study to determine the volume of material to be handled, the nature of the contaminant, some index as to the efficiency of removal required, and, finally, the appropriate design for each single installation. . . .

"The interest in [hydrocarbon pollutants] has already resulted in studies to prevent this contaminant from entering air-conditioning systems. It is of interest to note the increased use of activated carbon in air-conditioning systems to prevent the gaseous pollutants of our industrial cities, each of which is full of hydrocarbon vapors, from air-conditioned buildings. . . .

"Heating systems, air-conditioning systems can utilize oxidation catalysts and absorption procedures to improve the atmospheric conditions. . . .

"It can be easily demonstrated that the largest share of our atmospheric pollution originates from a fuel which is in common use. The increased use of gasoline and petroleum products points out the need for a more intensive effort to control the pollution originating from this fuel — both indoors and in the outside air."

Public health aspects of air pollution

Dr. W. Clark Cooper
U. S. Public Health Service

"The difficulties in pinpointing cause and effect relationships at lower levels of pollution and with respect to chronic exposures are staggering and help explain why discussions of health effects so frequently deteriorate into exchanges of discouraging generalities. Fortunately, unprecedented resources and energies are currently being brought to bear on these problems.

- INGESTION: Although adverse effects on live stock from the ingestion of forage contaminated with certain pollutants are well documented, the effects on humans of the ingestion of food and water so contaminated is entirely conjectural.

- EYE IRRITATION AND NUISANCE EFFECTS: In many locations throughout the country, the concentration of irritating pollutants has, from time to time, increased to the point where direct irritation of the eyes and mucosa has been observed. This has reached problem proportions most notably on the West Coast. Although studies to date have failed to reveal any permanent damage caused by this irritation, anyone who has personally experienced true smog can attest to its nuisance qualities. Among other nuisance aspects of air pollution which have public health significance are odors — which may induce nausea, reduce appetite, and cause individuals in affected areas to sharply restrict outdoor living.

- REDUCTION OF ULTRAVIOLET RADIATION: A decrease in solar ultraviolet radiation reaching ground level can be presumed to have some direct effects, although controlled studies are lacking to prove them. These health effects are probably in part offset by artificially irradiated milk and by other dietary supple-

Three air pollution conclaves

. . . starts on page 59

ments containing vitamin D. Absorption of solar radiation also has an indirect effect — that of setting the stage for the psychological manifestations of living in a community where diminished sunlight accentuates dirt and grime.

• CHRONIC EFFECT: The aspect of the air pollution problem that currently looms largest in the field of public health, and one already touched on briefly, is the possible effect of inhaling over a period of years low concentrations of the many substances which man's activities are adding to the atmosphere. Evidence is certainly lacking to incriminate air pollution, or any specific air pollutant, as a contributory factor in, say, the alarming incidence of lung cancer, but it would be extremely short-sighted not to explore the possibility with thoroughness."

Air pollution control legislation and regulations

H. C. Ballman
Air Pollution Control Association

"We can .... draw a few definite statements which will yield a vague pattern. They are as follows:

"1) Immediately, and for some time into the future, there will be a demand for more and more legislation to control air pollution. Most of this demand will be at the local level, but from time to time we will find demands placed at the level of state government and at the federal level.

"2) The federal government definitely has a place in the air pollution problem. They should be definitely interested in research and in investigations of a general nature pertaining to problems of air pollution. They should not be interested in activities having to do with the actual control or enforcement of air pollution control programs.

"3) The state governments may find it necessary to legislate assistance to local governments and help them to find ways and means for air pollution control programs. This may involve field testing programs, recommendations, etc. Here again, however, every effort should be made to leave the enforcement of the control program at the local level.

"4) Local governmental agencies have been, and I believe will continue to be, the accepted control agency groups for successful air pollution programs. Policing has always been considered local authority, and air pollution control ultimately yields to a policing activity.

"5) An acceptable method for controlling intercity and interstate air pollution is presently in great demand and, I believe, has yet to be devised. Many have suggested methods, but, to date, none has been found too practical except the District Program as is found in the Los Angeles District, the Allegheny County District, and others. Here the control authority has the right to take action in municipalities in a given district. So far as interstate air pollution is concerned, there is presently no effort being made to coordinate such an effort in any part of the United States."

Practical approach to solution of air pollution

C. W. Gruber
Air Pollution Control and Heating Engineer

"When does an air pollution problem exist? This question was recently asked of a speaker on air pollution from an industrial concern. His reply: 'An air pollution problem exists when the people complain or when local air pollution laws are violated.' This analysis is a pretty good one.

"There is no such thing as absolutely pure air so that air pollution in some form or other exists in every community. In order to define the problem in somewhat more specific terms, let us acknowledge that every community has polluted air in some degree. . . .

"One of the biggest problems to be settled in the years to come is: 'Can an acceptable standard be set for the quality of outdoor air?' This question should be of interest to the heating and ventilating engineers. Such a standard would be of tremendous value in setting goals in any air pollution prevention program.

"At the same time if such specifications were available, the design of air cleaning equipment could be approached with a great deal more certainty than it is today. At the present time, one community is only as clean, or cleaner, or not as clean as some other community. One community suffers from eye irritation, lack of visibility while others do not.

"There is now going on in many communities a growing number of air pollution evaluation programs, and data being accumulated every day. It remains now to assemble this information, study it, compare it with [the] objective of leading eventually to sufficient information on air pollution facts that a basis for the establishment of a standard of quality for outdoor may be eventually evolved."

Cleaning air pollutants

James W. May
American Air Filter Co.

"Industrial dust collectors cover a wide range of equipment but may be broadly classified into the following five categories:

"1) Dry centrifugal separators, which range from the conventional cyclone to the centrifugal separator combining a dust collector and fan in a single unit. The better designed collectors in this category are effective on particle sizes down to 10 microns, and this general classification is frequently used as precleaners for more effective types of collectors. Those units which combine a fan and centrifugal collector in a single unit have the added advantage of small space requirements.

"2) Ultrasonic agglomerators, which are used in conjunction with some type of secondary collecting device. Agglomerators of this type have proven to be quite expensive, and the efficiency provided appears to be a function of the concentration of the dust being handled.

"3) Wet collectors, which include washers, scrubbers, and wet

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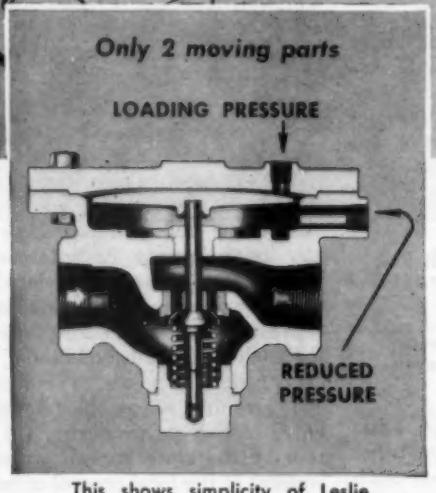

This shows simplicity of Leslie Class G-1 pressure reducing valve.

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Three air pollution conclaves

. . . starts on page 59

centrifugal units. The better designs of wet-type collectors will provide high orders of removal on particle sizes in the 1- and 2-micron range. They have the advantage of being able to handle high temperatures as well as moisture laden air. . . . . The chief disadvantage of wet collectors is the possibility of excessive corrosion and the vulnerability to freezing in cold climates. Washers, scrubbers, packed towers and similar adsorption devices have been used for the collection of gases and mists with varying degrees of success.

"4) Bag houses and fabric arrestors, [which] are effective on particles in the submicron ranges, and which give an excellent account of themselves when handling many types of dust. . . .

"5) Electrostatic precipitators, which are looked upon as being high-efficiency, high-cost collectors. The efficiency which they will provide is a function of the velocity of the gas through the unit — which in turn is reflected in the size of the precipitator for a given volume.

American Power Conference

Air pollution was covered in some papers at the recent American Power Conference in Chicago. Here are briefings for you:

Implications of current air-pollution legislation

Frederick S. Mallette
Executive Secretary
Committee on Air Pollution Controls, ASME

"For industry and business enterprises in general, all of this air-pollution-control activity means restrictive legislation and ultimate capital expenditures for abatement equipment. There is no doubt in my mind that except in the case of a major war, this movement is inevitable — it is just a question of time. For some communities, it is here. For others, it is just around the corner. For still others, it may be several years away.

"The important thing is to recognize it as a coming influence and to prepare ourself and one's company to face it intelligently and objectively. This does not necessarily mean one should look for trouble, but to consider it in such a way that there will be no loss of prestige or community good will, that *if* a problem in your company exists it will be handled efficiently and economically. Nothing is so distressing as the vast sums which have been wasted by industry on useless control equipment purchased hurriedly because of pressure from a community where the situation has become emotional and desperate. . . .

"As with every other cost added to a project, the consumer finally foots the bill. The public will ultimately pay for all air-pollution control, but, in the meanwhile, does not realize it. This provides the opportunity for a carefully-planned program of education."

Air pollution research . . . whose responsibility?

W. L. Faith
Vice President and Chief Engineer
Air Pollution Foundation, Los Angeles

"There is an attempt in some quarters to legislate air pollution out of existence; but unless such legislation is based on knowledge of the facts, the harm done to the health and well-being as well as to the economy of the community may override any good that will ensue.

"For instance, you can solve the air pollution problems from power plants by denying permission to operate them but our economy would be wrecked by so doing. Of course, in this country we eventually rescind foolish laws passed in the heat of emotion but in the process we have wasted time, talent, and money that might have been used constructively. . . .

"Industry has the responsibility for (a) determining the nature of its own emissions to the atmosphere; (b) developing air pollution control devices; (c) improving its fuels and combustion equipment so that the formation of air contaminants will be reduced; and (d) supporting community programs directed toward a solution of the air pollution problem beyond its own gates."

Industrial Hygiene Foundation

Air pollution came up for discussion during the 20th Annual Meeting of the Industrial Hygiene Foundation, Mellon Institute, Pittsburgh. This paper, focused on chemical industry problems, has industry-wide implications:

Air pollution control

M. P. Cross, Jr.
Manufacturing Chemists' Association

"Legislation for the reduction and control of air pollution can best be achieved by embodying the following seven principles: (1) creation of a bureau staffed with technical personnel, in most cases at the state level; (2) establishment of localized air pollution zones, generally on a county or intercounty basis; (3) appointment of local air pollution control commissions of representative community people for each local pollution zone; (4) registration of points of emission; (5) granting reasonable rights of entry to private property; (6) action by the state bureau with the consent of the local control commissions to first recommend and then, through the courts, enforce specific requirements to achieve a particular objective; and (7) cooperation in technical advancement through the state bureau.

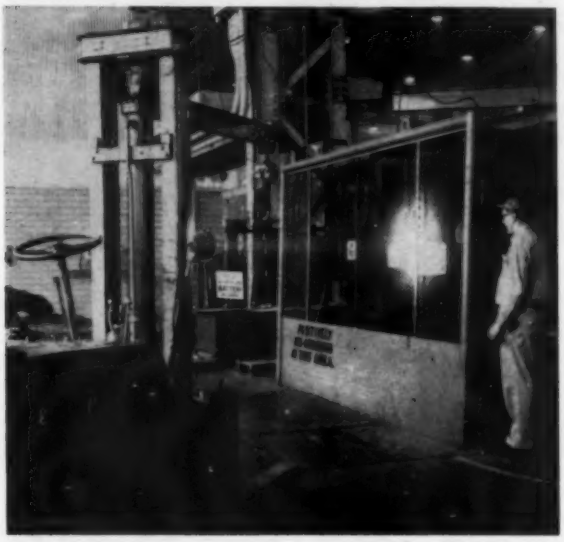
"I have emphasized our belief that specific air pollution incidents are unique, and should be handled at the local level — both as to corrective measures and legal requirements. Nevertheless, it is obvious that the subject, in its broad sociologic aspects, is a national one, transcending city and state lines."

ideas in action

. . . starts on page 31

Truck batteries take over in emergency

Storage batteries in industrial trucks come in for ingenious use at the plant of E. W. Bliss Company, Canton, Ohio. In event of a power failure, special floodlights are placed in brackets on the trucks and plugged into the truck battery. Lights are 200-watt, sealed-beam locomotive headlights adapted for use on 36-volt current. Strong, steady light can be provided anywhere in the plant or grounds that an industrial truck can reach. Batteries also supply emergency power to the plant telephone system by means of a special connection. Regular standby batteries

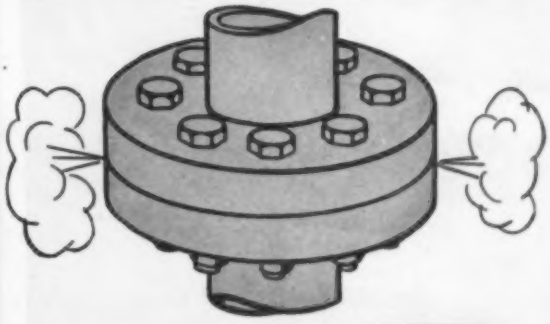


power the telephone system for only three hours, then a forklift truck is driven to the telephone room and plugged into the system. This keeps communications going for several extra hours. Occasionally the interbuilding diesel locomotive requires more electric power to start than can be supplied by its regular diesel starting batteries. An industrial truck is parked alongside the locomotive and the batteries are plugged into the starting system. This supplies the extra ampere-hour current required for cold weather operation.

Automatic fire-door closer avoids collisions

Finishing department trolley conveyor line at R-Way Furniture Co. rises from the first to fourth floor through a several-thousand-foot-long inclined tunnel. This could create a dangerous updraft in case of fire, so a pair of sliding fire doors is installed at the tunnel entrance. Installation of these doors solved the updraft problem. Mechanism for closing the doors must do two jobs: close the doors automatically, timing the closing to avoid collision with a pallet on the conveyor, and shut off the conveyor as soon as the doors start to close. A door-release system that is automatically actuated by fire detectors, but is electrically interlocked with the conveyor drive

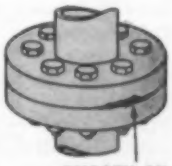
FLANGED JOINTS
which will not
LEAK



1 Make up your flanged joints with Smooth-On No. 3, heavy duty flange and gasket compound. The fine soft iron in this ready-to-use compound seals and protects. It will not bake out, it cannot be dissolved or driven away.

2 Pitted flange faces can be built up true with Smooth-On No. 1, THE iron cement. Finish with a coat of No. 3 on both sides of the gasket, and the joint is secure for very heavy duty.

3 Often a flanged joint may leak but it is impracticable to take it apart, at least not right away. Then force Smooth-On No. 1 into the leak. This hydraulic cement expands as it hardens, plugs any leak. All Smooth-On No. 1 asks is a firm surface against which to expand as it hardens.



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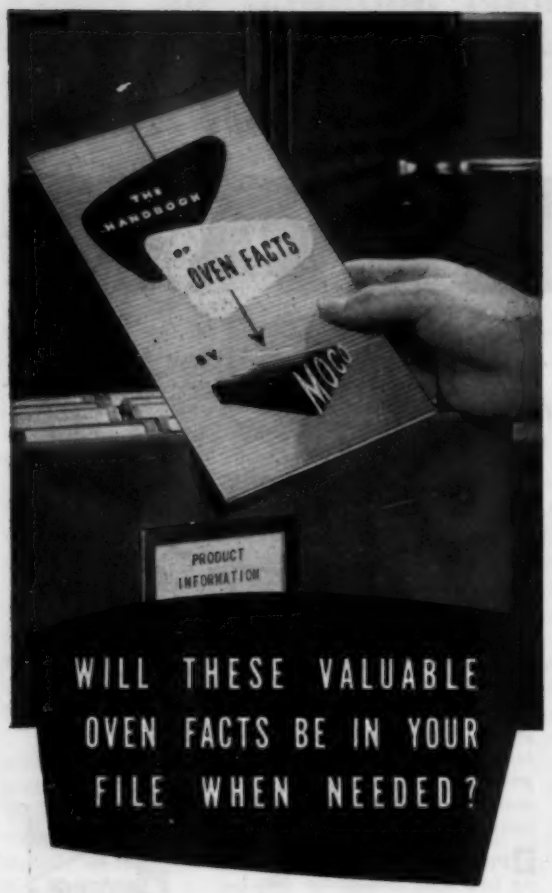

Ever looked in your reference file for specific information when you needed it—and found a void. Or perhaps you found *some* material, but not the right kind. We *all* have. Well, here's a chance to be sure you have a *lot* of information on one subject, at least—heat processing.

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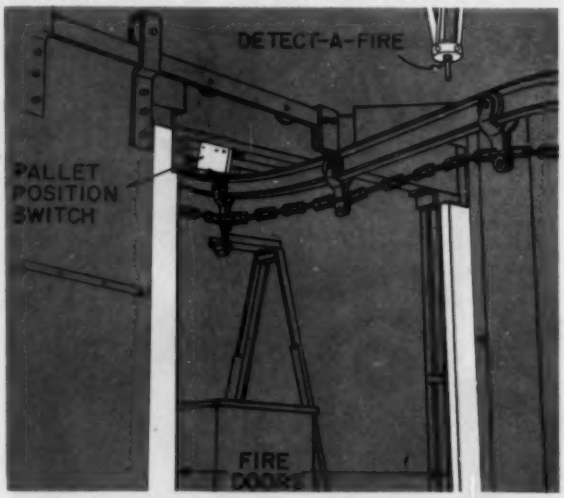
ideas in action

. . . starts on page 31

motor, was devised by the company's electric engineer. Sixteen Fenwal Detect-A-Fire units, set to actuate at 160 F, are located throughout the plant. When any detector senses an abnormal temperature condition, one of two sets of relay contacts wired in series with the door release mechanism is closed. Second set of relay contacts is controlled by a pallet-position switch mounted on conveyor rail just beyond the doorway. This switch keeps door release deactivated until doorway is clear.

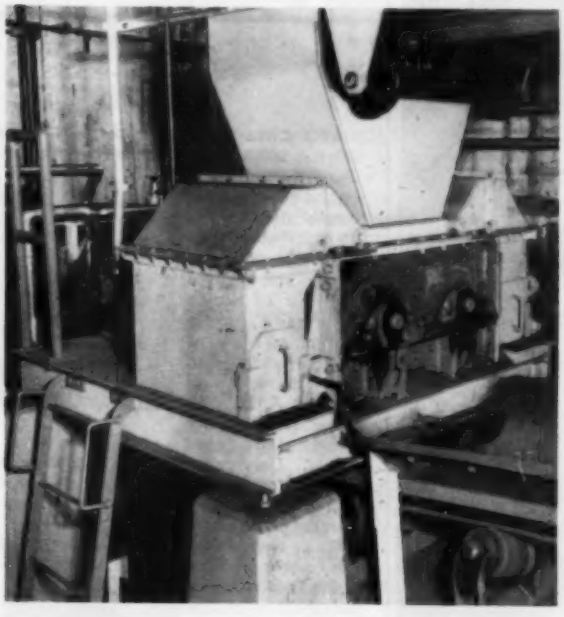
Pallets are mounted on six-foot centers on the conveyor. As an oncoming pallet clears the doorway, it trips the switch, energizing the second relay that controls the door release. Door-holding solenoids then release the doors, which slide shut by gravity. Simultaneously, pallet switch also deenergizes power relay for the conveyor motor, stopping conveyor before another pallet reaches the doorway. Two normally open switches associated with the doors prevent conveyor from being started unless doors are fully open.



Dual roll crusher stops coal clogging

Wet and sticky coal can now be handled without clogging by a new double-rotor knittel crusher, made by Stephens-Adamson Mfg. Co. Crusher combines the effectiveness of a double-roll slugging teeth crusher with inherent advantages of the hammermill-type crusher. Opposing rotation of the twin rotors tends to draw coal through the crusher, with heavy sectors breaking up lumps by impact. This action is similar in results to the action of slugging teeth on typical double-roll crushers. Following impact breakage, coal falls through the crusher to the grate bars where the heavy sectors force it through, reducing it to the desired size. Clogging in hammermill-type crushers is generally caused by buildup of material on the plate. This buildup often continues until the crusher throat opening is closed entirely. In this new design, breaker plates are eliminated. Although the new crusher uses two motors driving separate rotors independently, its performance on the basis of horsepower per ton of coal

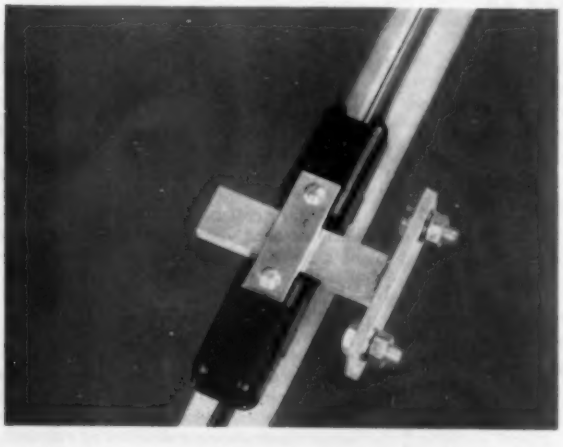
crushed is superior to that of single-rotor units. Tramp iron is automatically removed, too. Since the tramp iron cannot be driven through the grate bars, hanging sectors



drive it against a battery of fingers which lift out of the way allowing material to drop in a collecting box. With sectors hanging free there is no possibility of jamming the crusher or breaking the sectors since foreign material simply diplaces them and is thrown out.

Naked wires eliminated above power lifts

Safer working conditions with overhead power lifts are possible with a U-shaped Geon rigid vinyl extrusion. Extrusion is U-shaped for easy acceptance of the metal contact conductor. Because insulator fits snuggly around



conductor, as many as 3 to 12 powerlines can be installed close together where space dictates. Extruded insulator has high dielectric strength with low power loss. Coloring complies with code requirements. Extrusion will not warp, and it has high chemical and abrasion resistance. Ideally suited for use with overhead power lifts.

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The Wilson Tube Cutter costs two to eight times less than competitive tools. You also get a tube cutter with eight exclusive features:

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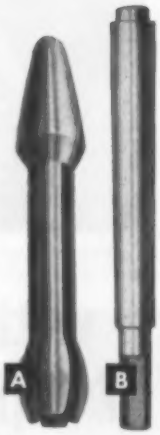
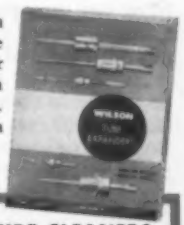


A Tube Pilot guides tubes through baffles and far sheet when retubing.

B Tube Knockout tool for manual or mechanical use.

It makes good sense to buy the Wilson Tube Cutter and accessories. For some more suggestions that will cut your tube maintenance costs, write for Wilson comprehensive Tube Expander Catalog. For tube cleaners, send for Wilson Catalog 77.



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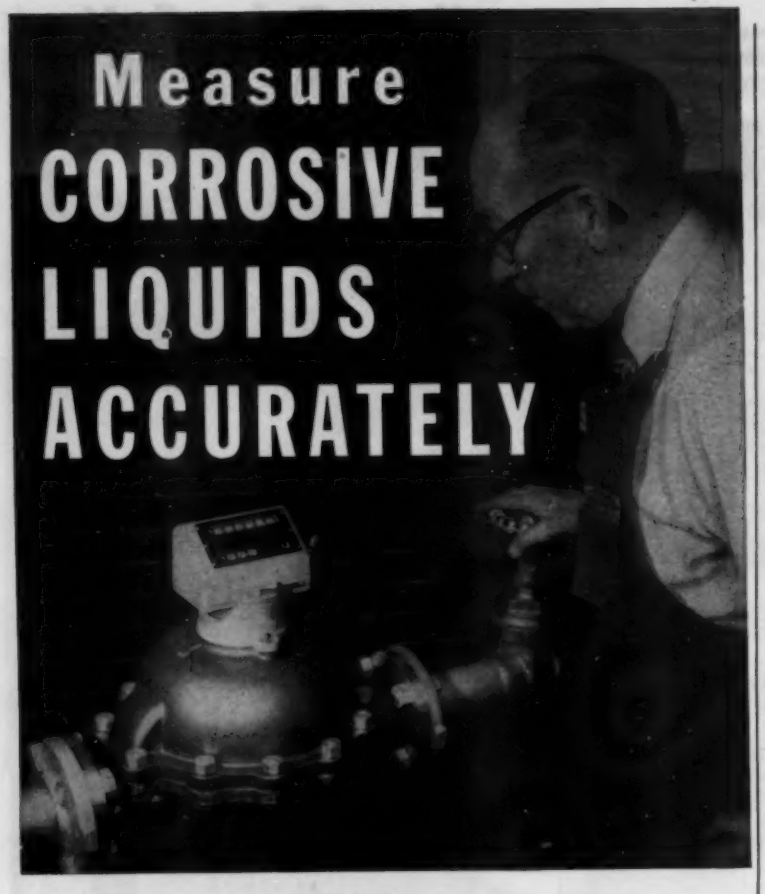

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names

I-T-E Circuit Breaker Company elects officers. **William Deans,** former vice president in charge of engineering, becomes vice president. Deans was formerly chief engineer and general manager of Sundh Electric Company and joined I-T-E as chief engineer in 1933. He served on Thomas A. Edison's personal staff after graduating from Cornell University in 1917. Deans is a member of NEMA; a Fellow of AIEE; and a member of several honorary engineering societies.

Deans

G. E. Heberlein, formerly manager of the company's Switchgear Division, succeeds Deans as vice president in charge of engineering. Heberlein was formerly employed by Westinghouse Electric Corporation as development engineer in supervisory and carrier-current frequency controls for communication systems; and later as sales manager in their Switchgear Division. He is a director of Eastern Power Devices, Ltd., a member of AIEE and NEMA.

Heberlein

The Association for Applied Solar Energy announces officers and directors for the coming year: **Jan Oostermeyer,** formerly president of Shell Chemical Co., president; **Walter T. Lucking,** president of the Arizona Public Service Co., vice president; and **John I. Yellott,** assistant director of Stanford Research Institute, secretary-treasurer. Association's projects for this year include establishment of a Solar Energy Library and two official publications.

American Institute of Electrical Engineers awards **Dr. Clinton R. Hanna** the 1955 Lamme Gold Medal. Dr. Hanna is an electromechanical systems expert, inventor, and associate director of research, Westinghouse Electric Corp. Dr. Hanna received the medal "for his fundamental calculations and developments in the field of electrodynamics . . . for his achievements in the design of generator voltage regulators, automatic rolling mill controls, and tank gun stabilizers."

make news

. . . personalities from industry & power

Alsop Engineering Corporation appoints **Stanley R. O'Dette** manager petroleum engineering division. O'Dette is a veteran of 28 years in the petroleum industry. He has an international reputation in specialized technical services in industrial oil applications—duties have taken him to Iceland, Europe, and North Africa. He served as technical advisor to the U. S. Military during World War II on all types of petroleum problems.

Byron Jackson Division, Borg-Warner Corporation appoints **B. D. Turner** product manager pump sales. Turner will headquarter in Los Angeles and will head the newly established Deepwell Products department. Prior to his appointment, Turner was regional company manager in Plainview, Texas.

Cleaver-Brooks Company appoints **Robert E. Sullivan** supervisor of newly formed sales department. Sullivan will be responsible for all sales of commercial heating boilers. He was formerly associated with the Mt. Hawley Manufacturing Co., as vice president in charge of sales. Prior to this, he was in sales promotion with the Crane Company.

Barnhart

Steinbach

Rosecky

Baldwin-Lima-Hamilton Corporation announces new officers. **Henry Barnhart** and **Milton Steinbach** become board chairmen. Barnhart is a graduate of the University of Notre Dame and Harvard University. He heads the company's construction equipment division, with plants in Lima, Ohio; Aurora, Illinois; and Los Angeles, California. Steinbach is also a board member of Armour and Company and Spiegel, Inc.

Joseph Rosecky becomes vice president in charge of the Corporation's Eddystone plant. Rosecky will direct activities at the works near Philadelphia where diesel locomotives, hydraulic turbines, and other types of heavy industrial products are produced. Rosecky has formerly held high executive posts at Allis-Chalmers, the A. O. Smith Company, and the Heil Company.

Federal Pacific Electric Company appoints **Richard F. Gibbons** general manager Gardner Transformer Division. Gibbons was formerly manager of Air Switchgear Engineering. Prior to that time, he was associated with Southern California Edison Company. Gibbons served as consultant on design of special test equipment developed by the University of California Radiation Laboratory during World War II.

General Electric elects officers. **Charles R. Pritchard** becomes vice president and **Cramer W. LaPierre** becomes executive vice president. Pritchard was formerly president and general manager of General Electric supply company and will continue to serve as general manager of this division.

LaPierre joined the staff of General Electric engineering in 1924. He is a member of AIEE, ASME, SAE, IAS, and Eta Kappa Nu. LaPierre will continue to have overall responsibility for electronic, atomic, and defense systems group.

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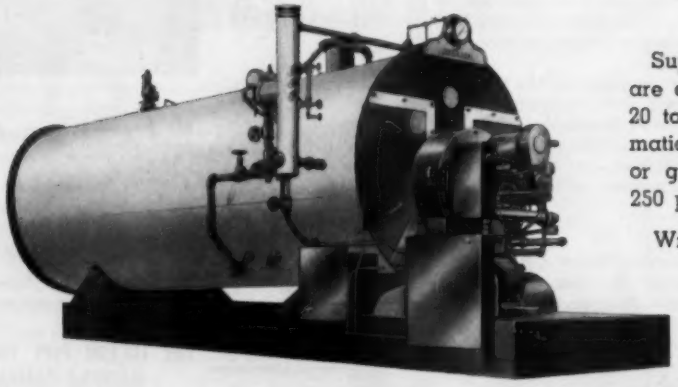

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handy guide

. . . to advertised products

Air cleaning equipment

Solving dust problems

Read page 18 and circle number 100

THE NORTHERN BLOWER COMPANY. Whatever you need in dust or fume control, be sure to check these bag-type, centrifugal, or hydraulic systems. Write for full information.

Control dust at 1/10 cost

Read page 72 and circle number 101

JOHNSON-MARCH CORP. No costly ducts, hoods, or fans are needed with this liquid system of dust control. Can be added to existing installations. Write for free problem analysis.

Blanketed by dust?

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PRAT-DANIEL CORPORATION. Industrial dusts and flyash can be controlled with engineered P-D Collector Systems. Reprint 102 tells how.

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Air conditioning, heating, ventilating

Reduce air-conditioning costs

Read page 77 and circle number 103

RUPPRICHT ROTARY ROOF COOLER. Here's an economical way to cool your building and reduce air conditioning costs. Easily installed—can be used on any roof. Details will be sent to you on request.

Boilers and boiler accessories

Can you bank on your boiler?

Read page 68 and circle number 104

SUPERIOR COMBUSTION INDUSTRIES INC. Get maximum efficiency with minimum installation, minimum maintenance, and minimum operating costs. Eighteen sizes of boilers burn oil, gas, or both. Factory assembled and fire tested.

Save on firing costs

Read page 87 and circle number 144

ORR & SEMBOWER, INC. Complete packaged burner assemblies that have proved themselves on O&S boilers are now available for existing units. Send for Bulletin 1231 to get full details on how you can save on firing.

Know-how solves steam problems

Read page 10, 11 and circle number 105

THE BABCOCK & WILCOX COMPANY. B&W boilers will precisely meet your every need for reliable, economical steam, and are backed by a policy of reputable service that assures complete satisfaction.

Doublecheck boiler water level

Read page 30 and circle number 106

THE RELIANCE GAUGE COLUMN COMPANY. Eye-Hye is a reliable cross-check for boiler water level. Easier to read than conventional gauges. Easy to install and easy to maintain. Send for bulletin.

Boiler accessories deluxe

Read page 77 and circle number 107

ERNST WATER COLUMN & GAGE CO. Inclined water gages, vertical bronze water gages, guards, plain sight illuminators, and weighted try cocks are described in new catalog. Send for your copy.

Simplicity means safety

Read page 81 and circle number 108

MAGNETROL, INC. Almost unlimited operating life is offered by these boiler water level controls that are so simple in operation. Available for temperatures to 750 F and pressures to 600 psi. Mail coupon for more facts.

Replace outmoded water heaters

Read page 19 and circle number 109

PICK MANUFACTURING CO. Instantaneous water heaters are suitable for high or low loads and they heat water instantly. They offer substantial fuel savings with low installation and maintenance costs. Send for free booklet.

Portable steam generators

Read page 8 and circle number 110

AUTOMATIC STEAM PRODUCTS CORP. If you need a compact, portable, electric operated high- or low-pressure steam generator, investigate the Hot Shot.

Building construction, maintenance

Mastic resists fire

Read page 29 and circle number 111

BENJAMIN FOSTER COMPANY. Fire resistive mastic is a must if you use mastic flooring. Simple to apply. Send for full information.

Get experience with sheet metal

Read page 21 and circle number 112

KIRK & BLUM MFG. CO. Your sheet metal work can be fabricated in any metal by

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handy guide

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this company with 50 years' know-how. Send for information on how they can help you.

Setting machinery?
Read page 86 and circle number 113
THE MASTER BUILDERS CO. Embeco premixed, nonshrink grout will give lasting results whatever the grouting job. Write for booklet that gives full information on grouting.

Electric distribution

Efficient disconnect switches
Read page 25 and circle number 114
ELECTRICAL ENGINEERS' EQUIPMENT CO. Save on cubicle construction costs and save on space with these safer, more efficient disconnect switches. Write for more details.

Package substations for indoor use
Read page 9 and circle number 115
SORGEL ELECTRIC CO. Package unit substations speed expansion and give earlier production with flexibility for future conditions. Particularly useful where low sound levels are important.

Eliminate motor burnouts
Read page 26, 27 and circle number 116
BUSSMANN MFG. CO. Damage from single-phasing can be prevented simply by using Fusetron dual-element fuses. Secret is a high time lag built into every fuse. Send for free bulletin and get the full story.

Get a guaranteed cable jacket
Read page 76 and circle number 143
WESTERN INSULATED WIRE CO. Synchro-Cured portable cords have a guaranteed Neoprene jacket for more flexibility and longer life. Write for details of this money saver.

Electric utilization

Tubular heaters for every application
Read page 5 and circle number 117
EDWIN L. WIEGAND COMPANY. Chromalox tubular heaters provide the kind of heat you need, exactly fitted to your specific application. Available in any shape. Send coupon for catalog and heating ideas.

Fuels and firing equipment

Automatic oil transfer systems
Read page 23 and circle number 118
THE ENGINEER COMPANY. Every part of Enco automatic oil heating and pumping systems is designed, assembled, checked, and tested before shipment. Installation and maintenance are simplified. Send for free bulletins.

Why do you need different coals?
Read page 4 and circle number 119
CHESAPEAKE AND OHIO RAILWAY. Best kind of coal for one boiler isn't necessarily good for another. Write for help on your coal problems.

Have you all the facts?
Read page 64 and circle number 141
MICHIGAN OVEN COMPANY. Send for this book of basic heat processing information written by the specialists. Get it now—you'll find it useful time and again.

Instruments and controls

Police your fluids
Read page 28 and circle number 120
HENSZEY COMPANY. Few moving parts cut downtime with these flowmeters that sound alarm at high or low flow. Send for bulletin.

Protect your gages
Read page 83 and circle number 121
REPUBLIC MANUFACTURING CO. Protect expensive gages from damage with Republic gage protectors and pressure snubbers. For working pressures to 10,000 psi. Send for bulletin.

Measure corrosives accurately
Read page 66 and circle number 122
BUFFALO METER CO. Now you can apply metered accuracy to measurement of corrosive liquids. Niagara chemical meters come in stainless, in sizes from 3 to 100 gpm. Mail coupon for more information.

Lubrication

Get efficiency with diesel lubricants
Read page 3 and circle number 123
SINCLAIR REFINING COMPANY. Trouble-proof diesel lubricants will soon pay for themselves with better performance, less corrosion, less carbon, and easier starting. Write for more information without obligation.

Better pressure lubrication
Read page 28 and circle number 124
NEW YORK & NEW JERSEY LUBRICANT COMPANY. Non-Fluid Oil does not need heating before it starts lubricating. Lasts three times as long as ordinary lubricants. Send for your free sample.

Is your turbine system clean?
Read page 88 and circle number 125
THE TEXAS COMPANY. Be sure your turbine system is clean by lubricating with Texaco Regal Oil. Why not write for a Texaco engineer to help you step up efficiency of all your power plant equipment.

Cut lubrication costs
Read page 15 and circle number 126
SUN OIL COMPANY. Why not take advantage of the similarity in your plant equipment? A lot of it can be lubricated by two products instead of several lubricants basically alike. Write for full story.

Maintenance items

Planned maintenance
Read page 76 and circle number 127
GRAPHIC SYSTEMS. Boardmaster Visual Control gives graphic picture of your operations. Systemize your maintenance visually. Save time and money—prevent errors. Booklet P-40 tells how.

No more leaking joints
Read page 63 and circle number 142
SMOOTH-ON MANUFACTURING CO. Stop flanged-joint leakage with low-cost, easy-to-apply Smooth-On No. 3. Send for free handbook.

Cheaper tube cutting
Read page 65 and circle number 128
THOMAS C. WILSON, INC. Get faster cutting at less cost with Wilson tube cutters. Will chuck into any air or electric drill. Simple to use. Write for catalog and read how you can cut your tube maintenance costs.

Tube expansion made easy
Read page 6 and circle number 129
AIRETOOL MANUFACTURING COMPANY. With the Airetool precision method, even the most inexperienced operator can roll uniform, tight tube joints in less time. Savings up to 30 percent have been reported. Write for an on-the-job demonstration.

Save time on pipe threading
Read page 67 and circle number 130
THE TOLEDO PIPE THREADING MACHINE COMPANY. Get easy, accurate operation with this quality ratchet threader. One set of high-speed steel dies cuts four sizes, 1- to 2-inch pipe.

Materials handling (bulk)

Handling bulk materials?
Read page 80 and circle number 131
CANTON STOKER CORP. Flo-tubes will handle fine or lumpy materials on any incline. Guaranteed by specialists in the field. Write for full story.

Piping, tubing, and hose

Custom-built flexible hose
Read page 8 and circle number 132
COBRA METAL HOSE. All sizes of seamless metal hose are custom-built for industrial power systems in all metals with all types of fittings.

Pumping equipment

Get all the facts on pumping
Read page 82 and circle number 133
AMERICAN-MARSH PUMPS. Compare every

Handling 12,000 Tons of Coal Daily with NO DUST

Close-up of J-M system in action at car dumper

Giant Power Plant controls dust at...

- **Rotary Car Dumper and Shakeout**
- **Barge Unloader**
- **Crusher Area**
- **Conveyor Transfer Points**

J-M dust control equipment was installed because of its high effectiveness and unusual flexibility of application. This is only one of many examples of how a Johnson-March system effectively solves dust problems for power stations and industrial plants.

J-M Dust Control costs only 1/10 as much!

No costly ducts, hoods, or fans. Almost no maintenance. An economical Johnson-March system can eliminate fire and explosion hazards, community dust nuisance, safety hazards, and maintenance problems. Even the efficiency of existing mechanical dust collectors can be improved by the addition of a J-M liquid system at low cost. Call or write — for an obligation free analysis of your problem of controlling dust, fumes or odors.

Johnson March

Dust Control Engineers

1724 CHESTNUT ST., PHILADELPHIA 3, PA.

CANADIAN REPRESENTATIVES: G. F. Sterne and Sons, Ltd., Brantford, Ontario

Circle 101 on READ-N-CIRCLE card for more data

handy guide

. . . starts on page 69

feature before you buy your pump. Pumps that look alike on the outside may not be alike inside. Write for bulletin or call your American-Marsh representative for assistance.

Valves and regulators

Outstanding for steam service
Read page 80 and circle number 134
JOHNSON CORPORATION. Direct-operated solenoid valves with stainless seats make light work of heavy-duty steam service.

Low-maintenance reducing valve
Read page 61 and circle number 135
LESLIE CO. Simple air-loaded, diaphragm-operated, pressure reducing valve is virtually maintenance free for steam heat or process steam application. Has only two moving parts and no seals. Suitable for pressures to 250 psi at 450 F. Send for bulletin today.

Get top check valve performance
Read page 2 and circle number 136
THE CHAPMAN VALVE MFG. CO. Tilting disc check valve gives top performance at lowest cost. Whether you want iron or steel construction, handle fluids or gases —there's a check valve for you. Send for free catalog.

Water supply and treatment

Demineralizers built in all sizes
Read page 83 and circle number 137
HUNGERFORD & TERRY, INC. A complete line of water conditioning systems is available from H&T. All sizes, all capacities, manual or automatic. Send for bulletin.

Get assistance on water treatment
Read page 7 and circle number 138
W. H. & L. D. BETZ. There is no need to hire a special staff to engineer your water conditioning. Just let Betz look after it, and you can forget you had a problem. Betz staff engineers are experts in water treatment. Why not let them help you?

Rapid scale removal is safe
Read page 34 and circle number 139
NORTH AMERICAN MOGUL PRODUCTS COMPANY. No special skill or ability is required to use Mogul Kwik-Kleen. Does a rapid scale removal job, yet does not attack metal, valves, gaskets, packing, or paint. Write for help with your scale problems.

Stop nozzle plugging
Read page 74 and circle number 140
RONNIGEN-PETTER CO. Quick-coupling filters that can be cleaned and back in service in 60 seconds are now available in any mesh. Handle from 5 to 800 gpm at pressures to 200 psi. Send for bulletin.

free bulletins

. . . just circle key numbers on READ-N-CIRCLE card on page 69

Air cleaning equipment

500-Series on dust and fume collectors

Exhaust fans for dust collecting and air handling are described in Catalog 1002-6. Includes complete performance tables and test curves. Plans and elevations of typical installations are shown. Additional bulletins contain descriptions, dimensions, capacities of Norblo bag and hydraulic type, and centrifugal dust collectors. THE NORTHERN BLOWER CO.

501-Dust collection manual

"The Collection and Recovery of Industrial Dusts," Manual 101, discusses various types of dust and techniques used in analysis, lists the factors which influence choice of equipment, and explains operation. Thirty-two pages. BUELL ENGINEERING CO., INC.

502-Improved electrostatic dust control

"Dust and Fume Control," 11-page Bulletin G406, tells of the improvements and refinements that have been made in electrostatic precipitation since the first Cottrell precipitator was erected. Also included are background material and illustrations of the Multiclone mechanical dust collector, the CMP unit, Dualaire dust collector, and Holo-Flite processor. WESTERN PRECIPITATION CORP.

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Air conditioning, heating, ventilating

503-Air conditioning history

Development of air-conditioning units from earliest attempts to present-day techniques are discussed in Booklet "Why RK?". Booklet compares three air-conditioning installations as to savings in initial and maintenance costs, on-the-site labor, materials, space, and year-round use. Diagrams show application of RK air-conditioning equipment in 12 different businesses. Excellent primer for basic understanding of air conditioning. Thirty-six pages. UNITED STATES AIR CONDITIONING CORPORATION.

504-Shorter cooling tower

Bulletin 5.1.902 describes the LoLine, an all-new cooling tower, specifically designed for air conditioning applications—with the lowest silhouette of any tower of 75 ton capacity or larger. Each component of the tower is discussed and a typical cross-sectional drawing shows operation. Four pages. J. F. PRITCHARD & CO.

Boilers and boiler accessories

505-Boiler setting and baffle data

More than 30 boiler-setting plans are shown, with an analysis of how each arrangement of tubes is baffled to meet the specific boiler design, in 20-page Bulletin BW-54. THE ENGINEER CO.

506-Answers to hot water problems

Answers to your hot water problems are given in Booklet "Methods and Means." Operation and advantages of the instantaneous water heater as compared to the indirect method heater are thoroughly discussed and illustrated. PICK MANUFACTURING CO.

507-Water tube boiler features

Water-tube package boilers, known as the Compak line, are described in seven-page Booklet 5000. Design and construction features are shown in cut away drawings with a list of standard and optional equipment, and performance curves. INTERNATIONAL BOILER WORKS CO.

508-Boiler instrumentation data

Modern power plant instruments and control systems are described with the aid of photographs and schematic drawings in Bulletin 55-605-83. Combustion instruments and panels are treated in detail. Twenty-four pages. THE HAYS CORPORATION.

509-Blowdown control chart

Determination of the rate of boiler blowdown and selection of a correctly sized heat exchanger are made possible with use of simplified Chart JPC, based on total dissolved solids in boiler water. Also given are recommendations for selection of blowdown equipment in accordance with normal operating conditions of boiler installation. HENSZEY CO.

510-Boiler instrument handbook

Boiler instruments to cover every phase of operation from water treatment to dust removal are contained in Bulletin GSP-901. Illustrations and text are combined to make this bulletin a necessity for engineers interested in boiler and steam problems. Twenty-six pages. HAGAN CORPORATION.

511-Package boiler tables

Bulletin PSG-2 contains tables of capacities, dimensions, and weights of nine typical package boilers. Includes illustrations of firing and control equipment plus recommendations for field installation for three pressure-classes available. Ten pages. HENRY VOGT MACHINE CO.

Building construction, materials

512-Mortar joints repaired simply

These seven simple steps for repairing worn or corroded mortar joints of brick or tile floors are presented in Bulletin E-37. Procedure involves use of non-shrink, Embeco premixed mortar. THE MASTER BUILDERS CO.

Compressed air supply

513-Family-album compressor catalog

A family album showing all the compressors and centrifugal pumps manufactured by the company is presented in Bulletin 603. Thumbnail sketches and brief descriptions of each type with sources of further information are included. Six pages. PENNSYLVANIA PUMP AND COMPRESSOR COMPANY.

514-Get cooler, drier air

How aftercoolers remove moisture from compressed air and gas is explained in Bulletin 130. Contains schematic flow diagrams showing how aftercoolers can cool and dry compressed air systems. Eight pages. NIAGARA BLOWER COMPANY.

515-Air compressor reference data

Engineering data and dimensional installation drawings are contained in Bul-

free bulletins

. . . starts on page 73

letin L-640-B1C to aid in selecting the proper air compressor for your plant air-supply needs. Complete compressor installation diagram is included along with various cutaway views of major components and accessories. An excellent reference bulletin. Twenty-four pages. WORTHINGTON CORPORATION.

Corrosion control

516-Pocket-size corrosion data

Unique, pocket-size folder describes 11 scale and corrosion control compounds. Contains recommendations for usage, including correct proportions. Compounds are available for scale and corrosion control, oxygen removal, pH adjustment, algae control, and for all problems encountered in water control. D. W. HAERING & CO., INC.

Electric distribution

517-Electric conductor data

Engineering data on laboratory tests and service records covering performance of electrical conductors are contained in engineering Bulletin EB-27. Operating temperatures, dielectric strength, aging, insulation resistance, moisture absorption, and power factor are discussed in detail. Descriptions of the many installation procedures are also included. ANACONDA WIRE & CABLE COMPANY.

518-Fuses for every purpose

Fuses for every purpose are illustrated and described in Folder 3. Also discusses Econ dual-element cartridge fuses for time-lag to protect against overloads and Economy delay renewable fuses and renewable links. ECONOMY FUSE & MFG. CO.

519-Current-limiting fuse charts

Hi-Cap fuses for protection of loads above 600 amperes are described in six-page Bulletin HCS. Two handy charts are included: Current Limiting Effect and Opening Time Curves. Explains use of these fuses in conjunction with Fusetron fuses. BUSSMANN MANUFACTURING CO.

520-Transformer oil is fireproof

Liquid-filled transformers using fireproof insulating liquid are described in Bulletin 61B6043. Fireproof liquid reduces fire hazards, eliminates costly vaults, and permits safe indoor installation. Describes complete line of transformers available in ratings from 3 through 15,000 kva. Four pages. ALLIS-CHALMERS MANUFACTURING COMPANY.

521-Control transformer handbook

Illustrations and data on control transformers is given in Bulletin GED-2767. Contains ratings, dimensions, prices, weights, and wiring diagrams for each model. Special section is devoted to panel and machine tool voltage-regulation curves for transformer selection. Transformers come in sizes from 0.05 to 5.0 kva with choice of primary and secondary voltages. Thirty-two pages. GENERAL ELECTRIC COMPANY.

522-Cable selection chart

Comprehensive selection chart for insulated electric cable included in Bulletin 1096. Lists minimum standard industry specification requirements for each insulation and covering. Describes trade name insulations, their limitations, and correct installation methods. Excellent reference for engineers concerned with purchase and use of electrical cable. Sixteen pages. THE OKONITE COMPANY.

523-Correct that low power factor

Booklet 50B describes the Unit-Cell Box Type Capacitors which offer easy-to-install, economical means of correcting low power factor for large or small power consumers. Twenty-seven pages. SPRAGUE ELECTRIC CO.

524-Lowdown on dry transformers

The applications, sizes, types, and construction of air-cooled dry-type transformers is described in Bulletin 155. Specifications are included. Special custom-built transformers and reactors are discussed. Eight pages. SORGEL ELECTRIC COMPANY.

Electric generation

525-Ready power for emergencies

Dependable electric generating plants for alternating and direct current, operating on gasoline, natural or LP gas, or diesel fuel, are described in Bulletin 279-2. Lists safety devices including high water temperature and low oil pressure shutoffs. Complete line of equipment includes sizes from 1 to 100 kw. Includes data on air-cooled models in sizes from 750 to 3500 watts. Twelve pages. THE READY-POWER CO.

Electric utilization

526-Electric motor data

Comprehensive descriptions and cutaway views of complete line of electric motors are given in this bulletin. Information on open dripproof, enclosed, and explosion-proof electric motors—all conforming to the new NEMA standards—is included. Ten drawings and graphs give reader essential data on performance and application features. THE LOUIS ALLIS CO.

527-Magnetic brake adjusts itself

Self-adjusting magnetic brake suitable for all types of dc motors is described in Bulletin B-6548. Describes construction details, operation, and applications, with recommendations for reducing maintenance costs. Illustrations show clutch action, brake clamping action, and brake releasing action for heavy-duty application. Includes torque-rating chart for series-wound motors, giving proper brake to use for torque requirements. Brakes can be adapted for ac motors by using a rectifier. Eight pages. WESTINGHOUSE ELECTRIC CORPORATION.

528-Speed control selector guide

Formulas and selection guides to determine the proper variable-speed transmission for your application are contained in Bulletin 65. Also includes dimensional installation drawings for eight types of transmissions. Sections devoted to accessory controls include complete line of automatic and remote control devices. Twenty-six pages. LEWELLEN MANUFACTURING COMPANY.

529-101 ways to heat with electricity

Industrial electric heating applications and methods are described in 32-page

RONNINGEN Filters stop Nozzle Plugging

Duplex Unit mounted below shower on vat. One can be serviced while other handles the shower. Quick coupling—no tools.

QUICK COUPLING

OFF-CLEAN-ON in 60 seconds

Any mesh—monel metal or 316 stainless steel—to 700 mesh. 5 to 800 GPM. Pressures to 200 PSI.

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RONNINGEN-PETTER CO.

Vicksburg, Michigan **Phone 5161**

Circle 140 on READ-N-CIRCLE card

Booklet, "101 Ways to Apply Electric Heat." Illustrated case histories show experience-tested ways to apply metal-sheathed Chromalox electric heating units in industrial jobs. EDWIN L. WIEGAND CO.

Fuels and firing equipment

530-Industrial heating handbook

New handbook provides plant engineers with basic concepts of industrial heat processing and heat control. Pruned of technical language, the handbook goes from a discussion of heat-to-fuel cost comparisons to design elements. Common formulas used in calculating heat and oven requirements are included. Bulletin 555 is a refresher course in process heating, and is a must for all plant engineers. Twenty pages. MICHIGAN OVEN COMPANY.

Heat exchangers

531-Condenser tube inserts

How to restore leaking condenser tubes to service by sealing off the deteriorated portion with inserts, is the subject of four-page Leaflet 500. Tube cleaners, expanders, and maintenance tools are listed. THOMAS C. WILSON, Inc.

532-Heat exchanger operation

Air-flow diagram in two-page Data Sheet 124 graphically shows operation of the Aero Heat Exchanger for water, oil, or compressed air cooling. How the unit saves cooling water, piping, pumping, and equipment costs is explained. NIAGARA BLOWER CO.

Instruments and controls

533-Capacitor-type fuel gages

Bulletin 546 discusses Liquidometer capacitor-type fuel gaging systems. Describes true weight gaging systems, compensated and uncompensated capacitor-type fuel gages, repeater indicators, fuel gage totalizing systems, selective indicators, and thermistor applications for fuel level warning and control. THE LIQUIDOMETER CORP.

534-All-purpose rotameter handbook

Illustrations and text in this catalog describe complete line of indicating, recording, controlling, and integrating flowmeters for liquid and gas measurement. Contains dimensional installation diagrams. Capacities; corrosion-resistant properties; and unique features of full-view, armored purge meters, and research rotameter equipment are given. Excellent reference catalog for engineers concerned with flow measurement. Sixty-eight pages. BROOKS ROTAMETER COMPANY.

535-Pocket-size thermocouple manual

Bulletin F 7255 is a convenient pocket-size reference manual for instrument men and engineers. Gives thermocouple temperature-millivolt equivalents. Temperatures are expressed on the International Temperature Scale of 1948, and electromotive force is expressed in absolute units. WHEELCO INSTRUMENTS DIVISION, BARBER COLMAN COMPANY.

536-All-purpose water flow meters

Principles of operation of nutating-piston-type meters are explained in Bulletin 36. It contains illustrations and data of typical installations, trap strainers, air release valves, high-pressure meters, and meter registers for the measurement of most fluids. Twenty pages. BUFFALO METER CO.

FREE COPIES

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537-Positive mercury switch controls

Positive controls for pressure, vacuum, temperature, liquid level, and other variables, equipped exclusively with sealed mercury switches are described in Bulletin 26/Me. Four pages. THE MERCOID CORP.

538-Test with tong-type ammeters

How to obtain accurate ac and dc current measurements safely and without

you can still get

copies of the special report

1956 Annual Review and Forecast

How does your plant stack up against today's best practice in the Power Services—and how will it stack up tomorrow? INDUSTRY & POWER's 1956 Annual Review and Forecast brings you up to the minute information about the trends in motion—information that you can use now to appraise your present facilities and to plan your future recommendations.

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next month in
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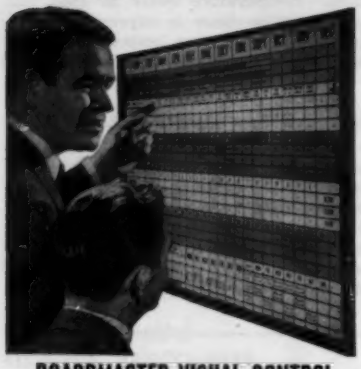
how to set
your own fuel targets

Do you really know how well your boiler plant is doing in terms of its potential efficiency? There may be many a slip of the Btu between the firebox and utilization devices. You can compute the amount of fuel you should use as a function of delivered load by using the special copyrighted chart appearing exclusively in INDUSTRY & POWER next month.

You can, with this chart, set a target for fuel consumption based on delivered heating load. Inventor of the chart is an engineer with responsibility for thousands of boilers currently under fire. He tells you all about setting fuel targets next month in the

June issue of
INDUSTRY & POWER

How To Get Things Done Better and Faster



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free bulletins

. . . starts on page 73

interrupting circuit is discussed in Bulletin TT-5515. Tong-type ammeters measure both ac and dc up to 1000 amperes with fourteen scale ranges. Test ammeters can be used safely for measuring current on lines up to 2300 volts. Includes information on voltage attachment that permits simultaneous readings of both voltage and current. Ammeter is priced within the range of portable test equipment for all power services engineers. Eight pages. COLUMBIA ELECTRIC MFG. CO.

539-How to select liquid-level control

Bulletin-1 discusses the factors to be considered in selecting a liquid-level control. It includes controls in types and sizes for handling practically any liquid, at any pressure and any temperature. Eight pages. MAGNETROL, INC.

Lubrication

540-Do's and don'ts for bearings

A helpful list of "do's" and "don'ts" to prolong bearing life appears in Bulletin 506. Also included is information on the storage and handling of industrial lubricants. Four pages. NEW YORK AND NEW JERSEY LUBRICANT CO.

Maintenance items

541-New electrodes for boiler repair

New line of low-alloy steel arc welding electrodes for boiler repairs and high pressure piping fabrication is contained in Bulletin 55CM. Electrodes eliminate weld cracking and reduce stress-relieving to a minimum. Preheat temperatures can be decreased to reasonable levels. THE CHAMPION RIVET COMPANY.

542-Hydraulic system chart

"Trouble-shooting Chart for Hydraulic Systems" is designed for display in shops. This chart will help operators and maintenance men spot and cure common troubles. Discusses such troubles as noisy pumps, leakage, overheating, and erratic action. Includes time-proven recommendations to cure most common troubles. SUN OIL COMPANY.

543-Modern tube expanders

The latest tube-expanding equipment available for fire-tube boilers, water-tube boilers, condensers, and similar heat transfer units is explained with the aid of drawings in news bulletin. Reference is made to bulletins with specifications and technical data. Typical boiler and condenser units are illustrated for which the expanders are recommended. Four pages. THE GUSTAV WIEDEKE COMPANY.

544-Repair methods handbook

Text and illustration in this 48-page handbook present repair methods for leaks in pipes, boilers, radiators, concrete, cinderblocks, and sheet and plate metal. Directory describes 12 typical repair cements and jobs they will do. SMOOTH-ON MFG. CO.

545-Renew worn cylinder walls

Patented process of honing and chrome plating worn cylinder walls is illustrated in this bulletin. Processed cylinder liners outlast cast iron liners three to five times. Four pages. VAN DER HORST CORPORATION OF AMERICA.

Materials handling (bulk)

546-How to store bulk materials

Storage bins for bulk materials such as ashes, coal, coke, sand or lime are fully discussed in this bulletin. Contains tables of densities of flowable materials, capacities, description of wall construction, test data, and other relevant engineering data with many photographs. Twenty-nine pages. The NEFF & FRY CO.

Mechanical power transmission

547-Are you using V-belt drives?

Here are answers to questions relating to basic principles and practices in engineering and use of multiple V-belt drives. "Modern Multiple V-belt Drives," Bulletin 20E8297 tells how to engineer V-belt drives. Provides tables and data. Describes modifications in V-belt drives. Thirty-six pages. ALLIS-CHALMERS MANUFACTURING COMPANY.

548-Conveyor belt design chart

Engineering data for standard conveyor belt construction is shown in color on this chart for eight of the most popular ply and material combinations. It shows theoretical ultimate strength, actual ultimate strength, faster strength, operating strength with fasteners and with splice, and troughing index. A separate data sheet is included. QUAKER RUBBER CORP., DIV. OF H. K. PORTER CO., INC.

549-V-belt engineering handbook

Complete engineering data including formulas and typical examples for designing V-belt drives are contained in "Engineering Handbook for Multi-V Belts." Includes forty-one pages of pre-engineered drives for "A" through "E" belt sections. Tables give horsepower ratings for each type of belt and gives examples of the procedure, data required,

and calculations to properly design V-belt and flat belt drives. A necessary manual for the library of all power services engineers. Seventy-eight pages GOODALL RUBBER COMPANY.

Piping, tubing, and hose

549-Plastic pipe handbook

Threaded- and socket-type fittings and flanges in both normal and high-impact grades are included in this bulletin. Includes installation information, pressure-temperature charts, chemical resistance tables, and other reference data. Polyvinyl chloride pipe material is resistant to corrosion, inert, non-toxic, and light weight. TUBE TURNS PLASTICS, INC.

550-Expansion joint selection guide

This data book is a must for any engineer interested in expansion joints. Catalog 135 contains piping layouts, installation instructions, and specifications. Also includes angular and lateral motion charts and 19 engineering tables. Twenty-six pages. FLEXONICS CORPORATION.

551-Piping flexibility analysis

Bulletin tells how to reduce cost of materials, design, and construction of processing and power piping systems. Includes development and solution of simultaneous equations for determining forces and moments in piping systems. Solves typical piping stress problem — high-temperature reheat system for utility central station—by both general analytical method and model test. Analyses permit specifications closer to the theoretically perfect pipe design. Twelve pages. FABRICATED PRODUCTS DIVISION, THE M. W. KELLOGG COMPANY.

552-Data on pipe fabrications

Specifications for all sizes of pipe from ⅛ to 24 inches in diameter are presented in 16-page Catalog 575C. Tables give data and descriptions of standard, extra strong, and double extra heavy pipe, spiralweld pipe, large od pipe, line pipe, electric-weld tubing, welding fittings and flanges, oil well casing, and water well casing. Discusses facilities for fabricating pipe for structural uses. L. B. FOSTER CO.

Pumping equipment

553-How to figure pump heads

How to determine total head against which pump must operate is only one of the valuable sections in 12-page Bulletin 353-1000 on the Bilton pump, a general purpose pump suitable for medium and low head service. BYRON JACKSON DIVISION, BORG-WARNER CORPORATION

554-How to care for pumps

How to install and take care of power pumps is visually demonstrated in Bulletin G-2198. Explains details of foundations, suction conditions, piping support, cleaning, alignment, lubrication, and testing. Includes maintenance information on initial and replacement packing, packing adjustment, common types of pump valves, and tips on trouble-shooting. A guide on power pumps for engineers and operating men concerned with pump installation and operation. Twenty pages. WORTHINGTON CORPORATION.

555-Piston packing data

How to select the proper pump packing for your equipment is described in Bulletin 5503. Engineering data is included on the full range of Pumcup compositions, textures, and types available for specified pressure, temperature, and corrosive conditions. Color-coding for easy identification of the proper composition for many fluids are listed, including gases, acids, and alkalies. Tables of standard sizes from 1- to 20-inch od are also included. Sixteen pages. DARLING VALVE & MANUFACTURING COMPANY.

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For free copies of these handbooks, bulletins and catalogs just circle the key numbers on the READ-N-CIRCLE card on page 69.

Refractories and insulation

556-Insulation, refractory handbook

Engineering data, formulas for calculating heat transmission, tables on heat losses from bare surfaces, and equivalent thicknesses of pipes are a part of the technical information contained in Bulletin IP-36A. Also includes descriptions of physical properties of the complete line of products. An excellent handbook containing information on all insulation and refractory problems. Fifty-two pages. JOHNS-MANVILLE.

565-How to build better masonry

Recommended practice covering materials, proportioning, mixing, and laying of units is offered in Bulletin WP6.55-35M. Three essentials to better mortar are given with quantity reference tables. Twenty-four pages. UNIVERSAL ATLAS CEMENT COMPANY.

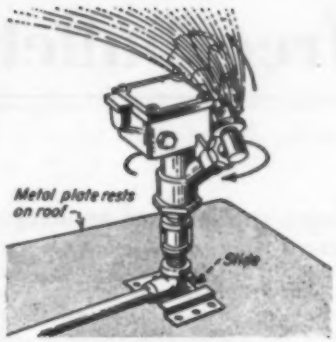
566-Refractory properties tabulated

Entire range of products and typical applications of each are covered in Bulletin 67. P.C.E. temperature service range, storage properties, setting characteristics, and other data are tabulated. Four pages. PLIBRICO COMPANY.

567-How to select refractory

"Boiler Refractories," 20-page Bulletin R-36, has been designed to provide operators of stationary and marine boilers with an authoritative guide for selecting the most efficient and economical refractories for their boilers. BABCOCK & WILCOX CO., REFRACTORIES DIV.

(more free bulletins on page 78)



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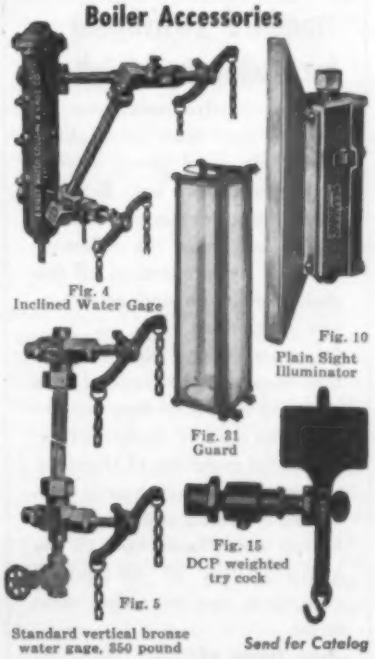

Fig. 4 Inclined Water Gage

Fig. 10 Plain Sight Illuminator

Fig. 31 Guard

Fig. 15 DCP weighted try cock

Fig. 5

Standard vertical bronze water gage, 350 pound

Send for Catalog

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free bulletins

. . . starts on page 73

Traps, strainers, and separators

557-Get "bone dry" compressed air

Bulletin describes how ball-float trap eliminates all water and oil from compressed air system. Equipment is entirely mechanical and automatic. Requires no maintenance—has minimum working moving parts. Contains information on line of after-cooler-separator-filters. JAS. A. MURPHY & CO., INC.

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For free copies of these handbooks, bulletins and catalogs just circle the key numbers on the READ-N-CIRCLE card on page 69.

568-Steam trap selector guide

Bulletin T-9 contains steam trap selector tables for 35 possible installations. Three-page fold-out diagram shows installation piping for 22 pieces of typical process equipment — with recommended steam trap and piping arrangements. Shows typical installations and gives recommendations for piping to obtain maximum steam trap efficiency. Twelve pages. YARNALL WARING COMPANY.

Vibration and noise control

558-Vibration encyclopedia

This nine-chapter booklet discusses meaning of vibration terms, vibration-measuring instruments, procedures, typical examples, and interpretation of results. Describes decibel conversion tables, vibration meters, and vibration analyzer equipment. Section is devoted to human response to mechanical vibration. Sixty-four pages. GENERAL RADIO COMPANY.

Valves and regulators

559-Why not a solenoid valve?

If you use direct operated solenoid valves for automatic or remote flow control of liquids and steam up to 400 F, or of high viscosity liquids you will want to read 11-page Bulletin V-2. Normally closed, normally open, explosion-proof normally closed, and three way valves are shown. THE JOHNSON CORP.

569-Control valve reference book

Three basic types of single-seated diaphragm control valves are discussed in 15-page Bulletin 5304. Cutaway views and charts with complete specification data make this a good reference book. LESLIE CO.

570-Direct-operated valves

Bulletin 1009 describes direct-operated water pressure reducing valves for industrial installations. Valves are recommended for intermittent flow and flows subject to abrupt fluctuation. Gives recommendations for use with fast-acting equipment. Includes capacity table and installation recommendations. Four pages. SPENCE ENGINEERING CO., INC.

571-Steam-jacketed valves illustrated

"Viscous Materials," four-page Folder E-200, will be of special interest to engineers of plants in which viscous materials are handled. Illustrations of steam-jacketed valves include a cross section and an exploded view. EVERLASTING VALVE CO.

Water supply and treatment

560-Clean your boiler in operation

How to clean your boiler while in operation is explained in four fact-filled pamphlets. The Ever Clean boiler process removes rust, prevents corrosion, and increases boiler efficiency. Also includes data on solving algae problems. NORTH AMERICAN MOGUL PRODUCTS.

561-Simplify water treatment

All information needed to accurately select water treating equipment for any plant, industry, or other institution is contained in this bulletin. Three basic types of exchange materials are described, including water and brine distribution mechanism and exchange material depth. Contains specifications including flow rates, exchange capacities, amount of salt, and shipping weight. Eight pages. ILLINOIS WATER TREATMENT COMPANY.

562-How to supply your own water

Methods of abstracting water from the ground or by infiltration through permeable beds of rivers or other bodies of water are discussed in 20-page bulletin. Performance charts for this company's collectors are supplemented with cross-sectional drawings and cutaways. RANNEY METHOD WATER SUPPLIES, INC.

563-All phases of purification

"Boiler Feedwater Treatment," 19-page Bulletin BFT-1, covers Inversand zeolite softeners, color process chemical softeners, and demineralizing units, including silica removal by ion exchange. HUNGERFORD & TERRY, INC.

564-Demineralizing handbook

"Handbook on Demineralizing," Bulletin 5800-B, compares various methods of water treatment including demineralizers and evaporators. Gives characteristics of various types of cation and anion exchange materials and operating costs. Forty pages. COCHRANE CORP.

572-Meet the film-forming amines

"Film Forming Corrosion Inhibitors Also Aid Heat Transfer," four-page Technical Paper No. 129, contains references to protection afforded by filming amines and attendant reduction in maintenance costs secured through protection against corrosion. W. H. & L. D. BETZ.

573-Supplementary water treatment

"No. 40 Series Supplementary Treatments," three-page Booklet 28X8226, discusses supplementary treatments for boiler makeup water such as treatments for softening traces of hardness, dispersives for conditioning of sludge, oxygen scavengers, and anti-foam agents. ALLIS-CHALMERS MANUFACTURING CO.

574-Answers about clarifiers

Clarifier and thickener requirements for a wide range of capacities and solids removal loads are listed in Bulletin W-800B-S-6000B. Presented in question-and-answer form, bulletin explains need for and function of circular sedimentation basins, sludge scrapers, and central inlet wells. Sixteen pages. INFILCO, INC.

next month in
INDUSTRY & POWER

standard switchgear for tailor-made job

Modern industrial switchgear has a good deal more adaptability in it than most power services engineers usually use. But wise use of that extra margin of adaptability can make the difference between an economical off-the-shelf installation and an expensive custom job.

Engineers of one New England firm found that they needed more capacity than what they thought there was room to accommodate. But skillful matching of standard, catalog-listed switchgear permitted increased capacity in the limited area. Read how all the adaptability of off-the-shelf switchgear can be called upon in the

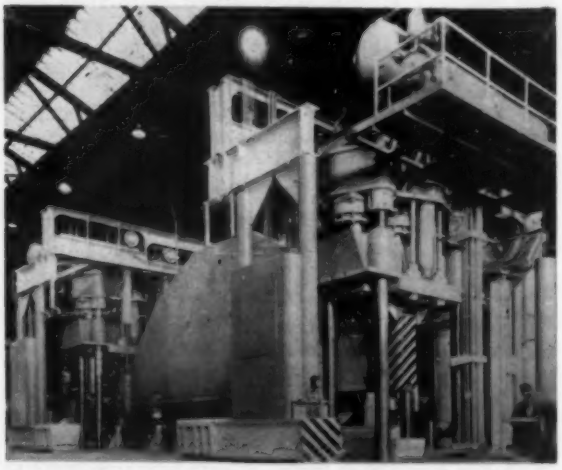
June Issue of INDUSTRY & POWER

spot news

. . . about industry & power

● B&W builds a new press

The Babcock & Wilcox Company has designed and built a new twin press for bending large boiler drum half-shells. New press has a capacity of 5000 tons and it can bend steel plate up to 7½ inches thick and 36 feet long. A plate this size would weigh about 50 tons. Four manipula-



tor hooks, powered by independent hydraulic circuits, place hot plates into position on the press. Each hook will lift 35 tons and is controlled by electric pushbuttons from either of two control consoles. Portable control box is provided for handling cold plate for final sizing operation. Press will double B&W's Barberton plant plate-bending capacity.

● Power show moves back to New York

After a four-year absence, the National Power Show will move to New York. Officially known as the 22nd National Exposition of Power and Mechanical Engineering, the display is scheduled for November 26-30 in the newly completed New York Coliseum. Show will be held under the auspices of ASME in conjunction with the Society's 76th annual meeting. Already 200 leading companies have engaged exhibition space.

● Transformers with aluminum are proving successful

Use of aluminum in the windings and terminal structures of dry-type specialty and distribution transformers rated up to 4800 volts has proved highly satisfactory. B. C. Bega, General Electric Company, recently told an AIEE session that "Customer acceptance has been complete, and the service record of aluminum-wound transformers has been excellent. Today we would consider the substitution of copper for aluminum in our designs only if the cost of raw copper were to return to a level comparable with that of aluminum or in those cases where specific severe space limitations definitely favor the use of the material possessing higher conductivity." He emphasized that his use of the word "substitution" did not connote inferior material used to overcome a temporary shortage or unfavorable condition. He said the price of copper has risen 30 percent in the last year and has been in short supply, while aluminum prices have remained relatively stable and the aluminum supply has generally remained adequate.

● Pollution bibliography will soon be available

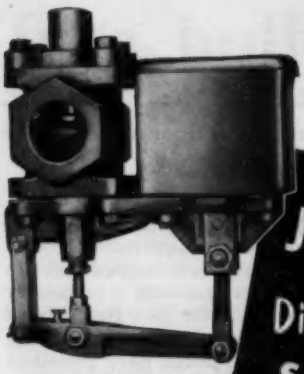
Library of Congress has agreed to prepare a continuing, annotated bibliography on air pollution for the Public Health Service. Bibliography will include references to the physical, biological, engineering, legal-administrative, and economic aspects of atmospheric pollution. Library of Congress will provide a continuing, up-to-date bibliography and an annual compendium that will be useful to all engineers interested in the abatement and control of community air pollution.

● Radiant heat from high-pressure water

Water at 300 psi will be used for heating in a radiant-acoustic ceiling in the office building of the $5 million Warner-Lambert Cosmetics Laboratory at Lititz, Pa. Only 3074 square feet of Burgess-Manning radiant ceiling will be needed to heat the 24,000 square feet of floor space. Hot water will also be piped to adjoining laboratory. In effect, it will provide comfortable radiant heat with little extra cost. Ceiling consists of suspended water coil to which perforated aluminum panels are attached. Water circulating through the coil heats the panels, which in turn radiate heat into the room. Sound control is provided by an acoustic-thermal blanket that covers the water coils.

● Big orders in the news

McMillan and Bloedel, Ltd., Vancouver, have ordered 12 mechanical-drive turbines for their pulp division plant at Port Alberni, B. C., from General Electric Company's Small Turbine and Supercharger Department. Turbines range from 160 to 2250 hp. . . . Contracts for the new Number Five turbogenerator unit to be added at Detroit Edison's St. Clair power plant have now been awarded. General Electric turbogenerator will be of the cross-compound, close-coupled type, operating at 2400 psi with 1050 F initial temperature and 1000 F reheat temperature. Boiler for the new unit will be supplied by Babcox & Wilcox Company, and will have a capacity of 2,100,000 lbs of steam per hour. Boiler will use a cyclone-type coal-burning furnace. Crushed coal will be burned without being pulverized. Condenser for new turbogenerator unit will be supplied by Allis-Chalmers Manufacturing Company. It will have 170,000 sq ft of effective condensing surface and will circulate 159,000 gallons of con-



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spot news

. . . starts on page 79

densing water per minute. . . . Foster Wheeler Corporation has been awarded a contract to supply two steam generators for a new power plant to be constructed by Public Service Electric and Gas Company at Ridgefield, N. J. Each boiler will supply 1,900,000 lbs of steam per hour at 2725 psi, 1100 F primary steam temperature and 1050 F reheat temperature. Units are of twin furnace natural circulation design. Fuel will be pulverized coal. . . . Four Griscom-Russell evaporators have been ordered by the Consolidated Edison Company of New York City to supply distilled water to the world's largest boilers. Two evaporators will be installed at Unit No. 3 — Astoria Generating Station, and the other two at Unit No. 2 — Arthur Kill Generating Station. Evaporators will produce distilled water, from IonXchange softened water, to be used for boiler feed make-up. Boilers are world's largest from standpoint of heat input and steam output.

● Lineup changes in the news

Commercial Filters Corporation has announced the merger of Honan-Crane and Michiana to form a new subsidiary, Indiana Commercial Filters Corporation. This follows the company's recent purchase of Houdaille-Hershey of Indiana, Inc. (makers of Honan-Crane filters) and the Filter Division of Michiana Products Corp. . . . Net assets, name, and goodwill of Mason-Neilan, (manufacturers of control valves and regulators) have been transferred to Worthington Corporation in exchange for Worthington common stock. . . . Arthur D. Little, Inc., industrial research consultants, have completed arrangements for acquisition of The Miner Laboratories, Chicago chemical consultants.

● More expansions in the news

Carrier Corporation, manufacturer of air conditioning, refrigeration and heating equipment, will spend $12 million this year for new buildings and equipment at its Syracuse, N. Y. headquarters. . . . Koppers Company, Inc. will build a multi-million dollar, 30 million pound annual capacity, low-pressure linear-type polyethylene plant in Woodbridge Township, New Jersey. Company is also joining Brea Chemicals, Inc., subsidiary of Union Oil Company of California in construction of a chemical plant in Los Angeles County for manufacture of a new type of polyethylene plastic. . . . ALCO Products, Inc. will spend over $1½ million on an expansion plan for its Beaumont plant. . . . Cummins Engine Company, Inc., of Columbus, Ind. has started on a $6 million capital program for this year, including construction of a 73,000 square foot addition to its manufacturing plant. . . . Manufacturing space of Electro-Motive Division of General Motors at its No. 1 plant in McCook, Illinois will be increased 42 percent by early 1957. . . . Beckman Instruments, Inc., recently broke ground in Newport Beach for a $2 million plant to house its Helipot Division, manufacturers of precision electronic components. Company's Arga Division will move to nearby Costa Mesa this year. . . . New 110,000-sq ft plastics plant will soon be built by the Parts Division of Sylvania

Electric Products, Inc., across the street from the Division's present Wire and Plastics Plant.... Borg-Warner Corp. plans to spend about $25,000,000 for expansion this year. Funds will be allocated to three projects — Marbon Chemical Division's new $10,000,000 chemical plant in Washington, W. Va., Byron Jackson Division's new electronics plant in Santa Ana, Calif., and a new research center in Des Plaines, Ill.

● This year looks as good as last year for air moving industry

Sales of air moving and conditioning devices increased by 8 percent in 1955. These devices included centrifugal, propeller and axial fans, and centrifugal and propeller fan unit heaters. Increases in building construction and emphasis on improved atmospheric conditions within occupied spaces have been responsible for rising sales. Another increase of 8 percent in 1956 is forecast.

● Engineers have their own radio news program now

First show ever devoted exclusively to covering latest engineering developments in Southern California's technical community began a thrice-weekly schedule on March 2 under the sponsorship of Beckman Instruments, Inc. Radio series "News For Engineers" is designed to keep technical personnel abreast of events in all phases of engineering. Five-minute programs also will seek to stimulate interest among students in engineering as a career. Show features news of significant technological advances in industry and education, important personnel changes in engineering circles, and news of the many technical societies.

● Utilities squawk at coal freight rise

Interesting development in the freight rate case was the protest of 20 electric utility companies. Petition was filed in behalf of 13 of the companies, with 7 other utilities furnishing information. Burden of their protest is contained in these lines: "Exorbitant freight rates on coal are forcing a revolution in the location of new coal-fired electric generating plants either completely off rail lines or with a minimum rail haul of coal. The extent of this flight from rail-hauled coal has now reached such proportions that stockholders of the coal-carrying railroads should be deeply concerned about the managements of the carriers which have followed such rate-boosting policies as to jeopardize millions of tons of profitable freight business."

● Plea for unity of engineers

A plea for unity of the engineering profession was made recently by James F. Fairman, vice president of Consolidated Edison Company, as honorary membership in AIEE was conferred on him. He said, "We exhaust ourselves in fruitless arguments about *how to organize* to do what needs doing when we should be concentrating our efforts on *doing what needs doing*. If we could only learn to cooperate in working to attain the important objectives of the profession, I am convinced we would more quickly devise the organization tools needed for more effective accomplishment.... One further caution — let's not waste

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■ Of all boiler water level controls, we believe Magnetrol to be the safest. Certainly it is the simplest.

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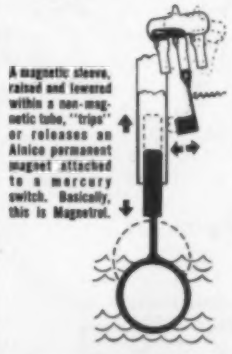
A magnetic sleeve, raised and lowered within a non-magnetic tube, "trips" or releases an Alnico permanent magnet attached to a mercury switch. Basically, this is Magnetrol.

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spot news

. . . starts on page 79

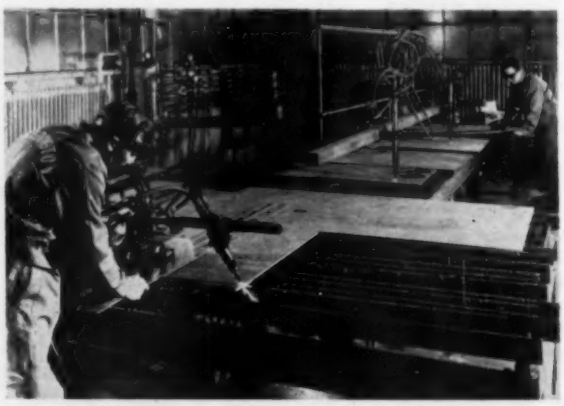
time debating the objectives, or what we mean by unity. Let's get at the obvious day-to-day problems and let the definitions and the long-range plans evolve from experience. Let's work harder at the grass roots and thereby lay a better foundation for unity at the national level."

● AGE has huge 5-year plan

Largest expansion in its 50-year history has been announced by the American Gas and Electric Company. AGE systems will spend $700 million for construction and installation of new facilities during the period 1956-60. This expansion will include addition of 2.6 million kw in generating capacity to meet the ever-increasing demands of the system's 1.3 million customers. This is more capacity than is presently available in any one of 33 of the 48 states. Program will raise the AGE system's total generating capability to 6.6 million kw by 1960, more than double the system's capacity in 1952, and more than triple its 1949 capacity.

● Worthington opens new welding research laboratory

Fully equipped welding research laboratory was unveiled recently at Worthington Corporation's Harrison, New Jersey Division. Laboratory will be used for welding application research, designing for welded construc-



tion, and building of prototype models. Facilities are available to fabricate and weld structures up to 10 tons. Personnel can be accommodated for complete training courses in design and weld applications. Facilities include a lecture room and a design engineering office.

● Seems as though engineering's future is assured

Only factor that could possibly retard the greatest scientific achievements we can foresee today would be a dearth of engineering talent. This is what Morris F. Ketay, President of Norden-Ketay Corporation said when he was awarded the Cooper Union Alumni Association's Gano

Dunn Medal for outstanding professional achievement. . . .

According to figures compiled recently by the National Merit Scholarship Corporation, a very high percentage of the nation's brightest youngsters are aiming for careers where they are needed most — in science and engineering. An original 60,000 high school seniors who were among the top 5 percent of their classes were narrowed down by the Merit Scholarship exams to 5078 semi-finalists, of which 56 percent of the boys and 16 percent of the girls desired to become engineers or scientists.

• Optical instrument supplants Ringelmann Charts

Recent investigation by U. S. Bureau of Mines has shown favorable comparison between the accuracy of a newly developed optical instrument and the 50-year old Ringelmann method of measuring smoke density. Developed by Mine Safety Appliances Co., the Smokescope is practicable for estimating smoke density from stacks of various heights and diameters, and with various surroundings. Observer views smoke through apertures that limit the field of vision to the subject. It is not necessary to shift the eye from smoke to comparison chart because the reference film disc is projected against the smoke being observed. In tests, accuracy was within −0.30 and +0.37 Ringelmann under any condition of smoke density, light, and background.

• New coal transportation system gets moving on Great Lakes

New era in coal transportation began March 22 when crane boat Marquis Roen loaded 7500 tons of Illinois coal direct from barges at the Material Service Corporation slip on the Calumet River in Chicago. Coal was destined for Consumers Power Company's B. C. Cobb plant at Muskegon, Michigan. Event was the forerunner of a large volume of all-water traffic from Midwest coal mines to Great Lakes Ports in both the U. S. and Canada. Usually, coal is shipped to Chicago by rail, unloaded at the dock, and then reloaded into lake vessels. This new system of bringing barges into Chicago and loading directly into steamers is a much more economical practice. It should offer considerable savings in transportation costs to many industrial and utility firms as well as opening hitherto inaccessible markets. This new all-water system of coal transportation is expected to lead to the construction of a Chicago facility that will be able to handle 1500 or more tons of coal per hour.

• Analysis of synthetic lubricants made simpler

A relatively simple schematic procedure for analysis of synthetic lubricants and additives plus a new paper chromatographic method of the separation and identification of antioxidants are presented in a recent report of Air Force research. These new techniques for identifying lubricant components are relatively quick and easy to apply in field analyses, have good reproducibility, good qualitative selectivity, and quantitative accuracy. Based on a year's research by Denver Research Institute, report traces steps in the schematic analysis of greases with mineral and synthetic base-oils, inorganic and organic gelling agents, soap-and urea-type thickeners, and antioxidants.

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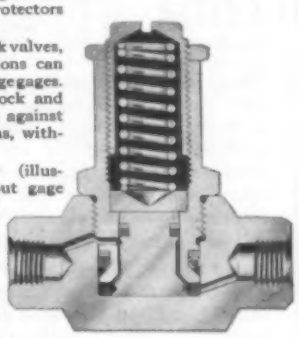

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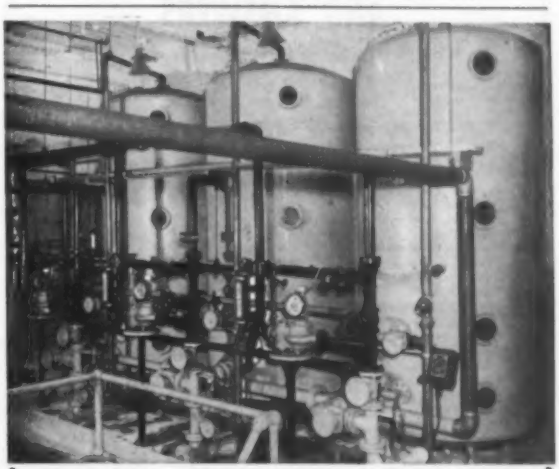

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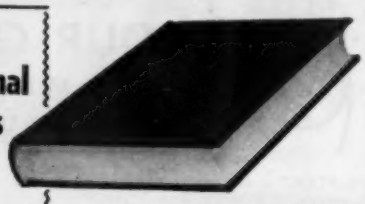

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A Survey of Direct Utilization of Waste Waters, by State of California Water Pollution Control Board; 82 pages; limited numbers available free.

Illustrations and text discuss utilization of waste water by industries, agriculture, recreational facilities, and wild life refuges. Presents in nontechnical language methods of utilizing waste waters for recharging water-bearing strata, and discusses the economic advantages of waste water utilization. Illustrations are below average and typography is not suited for long periods of continuous reading.

Contains an extensive bibliography for those desiring additional information on a specific phase of this topic.

This interesting discussion of waste water uses should be of interest to engineers faced with this problem. Text illustrates many advantages that can be obtained not only in tangible ways, but in the intangible value of improved public relations by making maximum use of waste waters.

Electrical Estimating — Second Edition, by Ray Ashley; 364 pages; $8.00.

This practical manual covers information needed to enable electrical estimators to quickly and accurately estimate electrical construction costs. Covers important elements in adequate fashion.

Separate sections, including recommended forms, are devoted to estimating requirements, preparing estimates, operating costs, sample estimates, preliminary estimates, labor units, and unit costs.

Book is written in nontechnical language and uses modern typography. It is more of a guide to methods and procedures used in listing equipment or making bills of material rather than why particular equipment was selected. Numerous sample estimates are included. This specialized field is covered in a satisfactory manner by this book.

Commercial and International Developments in Atomic Energy, by The Atomic Industrial Forum, Inc.; 598 pages; $8.50.

This volume contains the proceedings of the Forum's 1955 Annual Conference, held in Washington. Includes pictorial supplement on the first Trade Fair of the Atomic Industry, held in conjunction with the Conference.

Contains many sections and line drawings of reactor installations with accessories and adjacent facilities. Text is devoid of complicated mathematical formulas, and relies on descriptive text rather than on higher mathematics to convey information to the reader.

Includes articles on power, test and research reactors, radiation and radioisotopes, reactor safety, business opportunities in atomic energy, fuels and source materials, atomic activities outside the U. S., and a review of the Geneva Conference papers. Typography and illustrations are easy to read. Articles are included by many well-known authors in the field of atomic energy.

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May 17-19	NY State Society of Professional Engineers 30th Engineering Ind. Exp.	Statler Hotel New York City
May 23-26	National Society of Professional Engineers Annual Meeting	Atlantic City
June 17-21	ASME Semiannual Meeting	Statler Hotel Cleveland
June 25-29	AIEE Summer and Pacific General Meeting	San Francisco
Sept. 10-12	ASME Fall Meeting	Denver
Sept. 17-21	ISA 1956 Conference and Exhibit	Coliseum New York City
Sept. 25-27	Third Annual Conference Atomic Industrial Forum	Morrison Hotel Chicago
Oct. 1-5	AIEE Fall General Meeting	Morrison Hotel Chicago
Oct. 8-10	ASME Lubrication Conference	Atlantic City New Jersey
Oct. 11-12	Armour Research Foundation National Noise Abatement Symposium	Sherman Hotel Chicago

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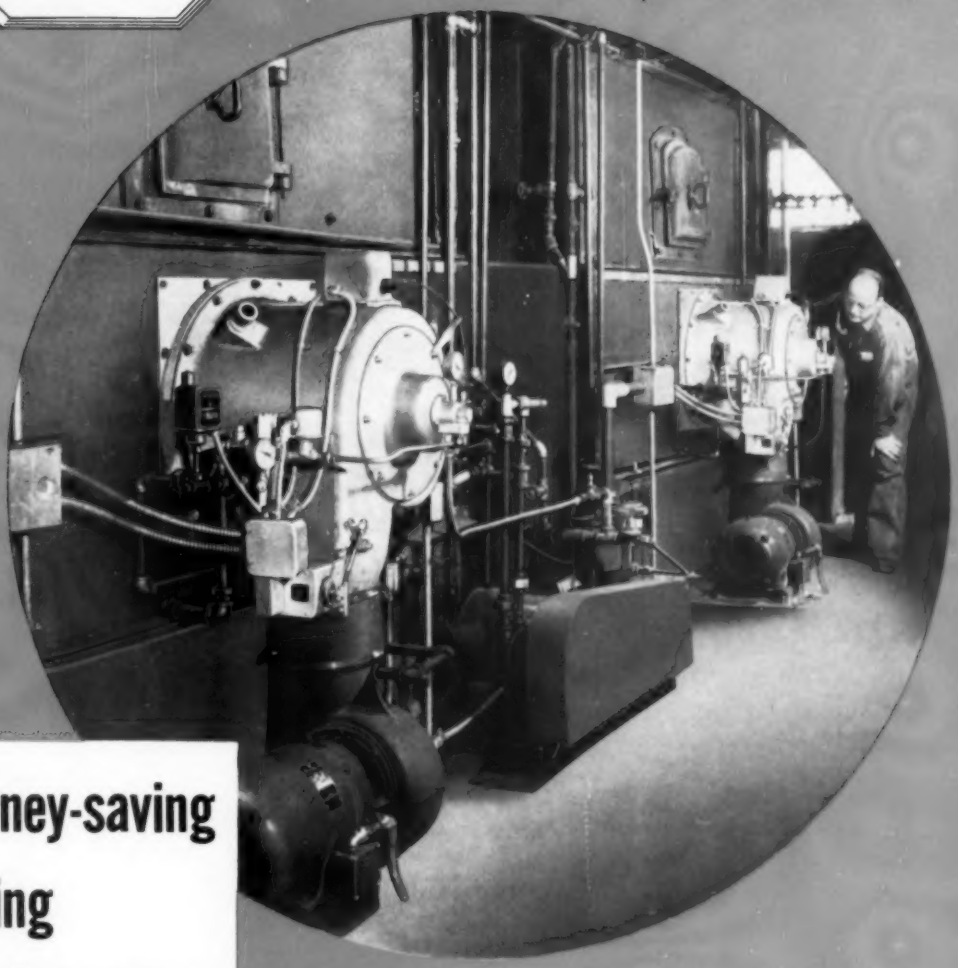

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